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Development of the Heat-Recovery Incinerator Feasibility (HRIFEAS) Computer Program

by
Kenneth E. Griggs

Army installations must provide their communities with adequate, economical waste disposal. To minimize disposal costs and use the thermal energy available in waste, the Army has constructed six Heat Recovery Incinerator (HRI) plants and has nearly completed a seventh. All the working HRI plants have experienced significant design and operational problems, highlighting the need for a consistent, standardized method to evaluate HRIs in the planning stages. The Heat-Recovery Incinerator Feasibility (HRIFEAS) computer program was written to fill that need by allowing a comparison of the costs of building and operating HRIs with landfill costs.

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FOREWORD

This work was performed by USACERL for Headquarters, U.S. Army Corps of Engineers (HQUSACE) under project 4A162781AT45, "Energy and Energy Conservation"; Work Unit A-007, "Heat Recovery Incinerator (HRI)." Mr. Qaiser Toor, CEHSC-FU-M, and Mr. Fred Eubank, CEMP-ET, were the HQUSACE Technical Monitors.

The work was conducted by the Energy and Utility Systems Division (FE), of the Infrastructure Laboratory (FL), of the U.S. Army Construction Engineering Research Laboratories (USACERL). The USACERL principal investigator was Mr. Kenneth Griggs. Dr. David Joncich is Division Chief, CECER-FE, and Dr. Michael O'Connor is Laboratory Chief, CECER-FL. The USACERL technical editor was Mr. William J. Wolfe, Information Management Office.

COL Daniel Waldo, Jr., is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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DEVELOPMENT OF THE HEAT-RECOVERY INCINERATOR FEASIBILITY (HRIFEAS) COMPUTER PROGRAM

1 INTRODUCTION

Background

Like many U.S. communities, Army installations must provide safe, adequate waste disposal. Landfills on military facilities must meet the same Federal and local environmental regulations as commercial landfills. In some cases, the waste is disposed of offsite by a contractor; the cost for this service has been rising. To minimize disposal costs and take advantage of the thermal energy available in waste, the Army has constructed six Heat Recovery Incinerator (HRI) plants; a seventh is nearly complete (Table 1). All of the constructed plants have experienced significant design and operational problems; after construction, one plant was found to be economically inoperable.

The first five plants were constructed by the Army as energy conservation projects under the ECIP (Energy Conservation Investment Program). While the plants built under ECIP did not yield high energy savings, they did produce significant savings in waste disposal costs. Even though they failed the ECIP economic criteria, they might have paid for themselves as waste disposal facilities alone. Although three of the previously operable plants are presently shut down, primarily due to maintenance problems, these Army installations still have an interest in either restoring the plants to operation or in sending their waste to commercial HRIs.

Part of the research conducted by the U.S. Army Construction Engineering Research Laboratories (USACERL) has focused on potential solutions for the problems of waste disposal. An examination of the various plants indicated that three out of the first five plants have major design problems, including insufficient amounts of waste, insufficient steam demand, insufficient tipping floor size, a mismatch between equipment and building, and poor specifications. These faults appear to have resulted from a general lack of experience with such facilities. The projects were begun without the benefit of a uniform guidance or past history. In addition, plans for these facilities were based on unrealistic expectations. These HRIs were funded as energy-conservation projects, when they should have been built primarily to change typical municipal waste into well-burned ash to minimize disposal volume and cost.

Table 1

Constructed Plants

Fort Eustis, VA
Fort Leonard Wood, MO
Fort Knox, KY
Redstone Arsenal, AL
Fort Rucker, AL
Fort Dix, NJ
Fort Lewis, WA*

*Under Construction

There is a need for a standardized, consistent method to realistically evaluate plans to construct HRIs by comparing the costs of building and operating HRIs with alternative waste-disposal methods. The Heat Recovery Incinerator Feasibility computer program was written to fill that need.

Objectives

A primary objective of this HRI-related research was to develop an "expert system" computer program, incorporating past experience and research, to perform the technical and economic analyses for proposed HRI projects.

Secondary objectives of this study were: (1) to develop an initial version of the HRIFEAS program; (2) to determine the technical validity of the program; and (3) to identify changes needed to improve the HRIFEAS source code or the interface between HRIFEAS and the Life Cycle Cost in Design (LCCID) program.[1]

Approach

This study mapped out a standardized analytical procedure that identifies the input data needed to produce the outputs required for the economic analysis. Assistance was obtained from Argonne National Laboratory (the U.S. Department of Energy [USDOE] center of expertise for waste-to-energy technologies) to develop algorithms to estimate HRI capital, operating costs, and performance. The LCCID program was chosen as the most appropriate means to do the economic analysis. Successful, automatic interface with the LCCID program is considered very important to the usefulness and validity of the HRIFEAS program. USACERL personnel tested the resulting (HRIFEAS) program on several in-house studies. The Corps of Engineers Seattle District also tested HRIFEAS as part of an ongoing Technology Transfer Test Bed (T^3B) project. As a result of these tests, subsequent changes and improvements were then made to the program.

Scope

The HRIFEAS program is based on starved or controlled-air incinerators with a minimum plant size of 10 tons per day (TPD)* and a maximum size of 200 TPD (7-day week). This size range accommodates most Army facilities, which produce from 30 to 60 TPD of waste. Only a few posts produce from 120 to 150 TPD. In the private sector, HRI plants of this size are more than twice as common as larger units.

HRIFEAS is designed to help individual military facilities to consider the cost factors involved in HRI plant construction; servicing engineer districts to evaluate potential projects; or the supervising engineer division and Headquarters, U.S. Army Corps of Engineers (HQUSACE) to check the District's work.

From the standpoint of program operation, HRIFEAS is a user-friendly program in that it provides opportunities for the user to confirm or change any entered data, but does assume the user has a minimal knowledge of computer use.

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[1] Linda K. Lawrie, *Development and Use of the Life Cycle Cost in Design Computer Program (LCCID)*, Technical Report (TR) E-85/07/ADA162522 (U.S. Army Construction Engineering Research Laboratory [USACERL], November 1985).

* 1 ton = 907.1848 kg.

Mode of Technology Transfer

Publication of this report will be accompanied by announcements in DEH Digest and USACE publications such as the EIRS Bulletins.

2 HRIFEAS COMPUTER PROGRAM

Introduction

The first step in any project is to perform a technical and economic evaluation. The HRIFEAS computer program was developed to analyze the feasibility of heat-recovery incinerators by preparing and analyzing data for economic analysis. Figure 1 shows sample program output. The actual economic evaluation is done by a second USACERL-developed program, LCCID, which performs a complete life-cycle cost analysis. Figure 2 shows sample LCCID output. HRIFEAS and its associated batch files drive LCCID so that the user does not have to be familiar with or directly interact with LCCID.

HRIFEAS source code was written in BASIC computer language, and was then compiled to run on any IBM-compatible microcomputer.* The two program disks include both HRIFEAS and LCCID. Normally, the user inserts the disks into the "A" and "B" floppy disk drives and then turns on the computer. The self-booting disks automatically start the program. A special batch file is included to help load the files onto a hard disk and run the program from there. A one page set of instructions, along with a warranty disclaimer, provides all of the assistance needed to run the program. After each run it is necessary to restart the program either by rebooting the computer or typing "AUTOEXEC" followed by pressing the <return/enter> key.

To run the program from a hard disk, insert Disk A into drive "A:" and turn on the computer. As instructed by the opening message, press the Control <CTRL> and the "C" keys at the same time to terminate program startup. Then run the hard disk installation program by typing "HDINST" and pressing return/enter>. The user will be prompted when to switch disks. The batch file will create a C:\HRI subdirectory to contain all the necessary files. To begin execution, go to the subdirectory and type "HRI". Any other installation will require special assistance from USACERL.

The program prompts for all needed information. Default values and help lists are available to provide appropriate input ranges. Inappropriate responses are rejected and the user is prompted for better information. If user-entered values fall outside expected ranges, the values are flagged and the user may change the response. The user also may choose whether or not to run the LCCID program. All selected default values are also flagged so the user may enter actual values before doing a final run to request project approval and funding. Multiple runs may also be made as part of a sensitivity analysis. Although not all details are included, Figure 3 shows the flowchart for the HRIFEAS program.

Operating Instructions

The user instructions supplied with the disks begin with a warranty disclaimer statement. Note that the accuracy of this program is entirely dependent on the user-supplied input data. It is the user's responsibility to understand how the input data affects the program output and to use the output data only as intended for a technical and economic analysis of potential HRI projects. This program's analysis uses certain algorithms to approximate results, and should be used only to screen projects in their initial stages. The output may be used to prepare DD Form 1391[2] and the Project Design Brochure. The program may also be used as a template for a more detailed analysis by the servicing Engineer District. If an attempt

* The source code for HRIFEAS and its batch files can be found in Appendix A.

[2] DD Form 1391, "Military Construction Project Data" (Department of Defense [DOD], December 1986).

Session Number: 1

SUMMARY OF INPUTS	
INSTALLATION NAME:	Ft. Knox
REGION:	4
PROJECT FISCAL YEAR:	95
WASTE TYPE:	2
HEAT CONTENT:	4500
*WASTE QUANTITY:	40 tpd (7 day)
DAYS/WEEK:	7
SHIFTS/DAY:	3
LANDFILL LIFE:	2 years
LANDFILL REPLACEMENT COST:	$5,422,731
LANDFILL COSTS:	$51.55/ton
ASH DISPOSAL COST:	$51.55/ton
FUEL TYPE:	distillate oil
*FUEL COSTS:	$0.56/gallons
AUXILIARY FUEL TYPE:	natural gas
AUXILIARY FUEL COSTS:	$2.46/Kcuft
#ELECTRICITY COSTS:	4.6 ¢/KWh

Default value for gas or electricity which must be verified.
* Value given differs significantly from the table value.
** NOTE: MBtu means MILLIONS of Btu's.

SUMMARY OF OUTPUTS	
TONS PER 7 DAY WEEK OF WASTE:	280 tons/week
INDIVIDUAL INCINERATOR CAPACITY:	20 tons
NUMBER OF INCINERATORS REQUIRED:	3
TOTAL FACILITY CAPACITY:	60 tons/day
CAPITAL COSTS:	$57,369/ton
APC CAPITAL COST:	$10,129/ton
HRI CONSTRUCTION COSTS:	$4,049,881
O&M COSTS:	$33/ton
HRI O&M COSTS:	$474,690/year
LANDFILL SAVINGS:	$359,496/year
HEAT PRODUCTION:	67,331 MBtu/yr
FUEL COSTS:	$4.28/MBtu
AUXILIARY FUEL COST:	$2.39/MBtu
ELECTRICITY COST:	$13.39/MBtu
ENERGY RECOVERY FACTOR:	85.0%
NUMBER OF HOURS OPERATIONAL:	168 hours/week
NUMBER OF MBtu OF FUEL NEEDED PER TON OF WASTE BURNED:	0.249 MBtu/ton
GROSS FUEL SAVINGS:	$339,399.03/yr
YEARLY AUXILIARY FUEL COSTS:	$8,643.69/yr
YEARLY AUXILIARY FUEL QUANTITY:	3,623 MBtu/yr
YEARLY ELECTRICITY COSTS:	$45,141.01/yr
YEARLY ELECTRICITY QUANTITY:	3,371 MBtu/yr
NET FUEL SAVINGS:	$285,614/yr

** NOTE: MBtu means MILLIONS of Btu's.

Figure 1. HRIFEAS Output.

LIFE CYCLE COST ANALYSIS STUDY: KNOX

LCCID 1.035 DATE/TIME: 08-16-89 11:25:41

PROJECT NO., FY, & TITLE: P000 FY 89 HEAT RECOVERY INCINERATOR

INSTALLATION & LOCATION: FT. KNOX KENTUCKY

DESIGN FEATURE: ALTERNATIVE EVALUATION

NAME OF DESIGNER: GRIGGS

SUMMARY REPORT

CRITERIA REFERENCE:FEDS/A-94 (Army TM 5-802-1, Para. 2-2,5&6)

DISCOUNT RATE: 10%

ALTERNATIVES ANALYZED			
ALT ID.	DESCRIPTION/TITLE	LCC (NET PW) ($ X 10**3)	INITIAL COSTS++ ($ X 10**3)	AVG. ANNUAL ENERGY USE (10**6 BTUS)
A	LANDFILL	3262	119	56520
B	HRI	4427	2898	1349

TABLE I. KEY DATA FOR ECONOMIC RANKING PURPOSES

++ INCLUDES PRE-BOD COSTS, IF ANY

ALT ID.	INITIAL INVEST-MENT COSTS++	ENERGY COSTS	RECURNG M&R & CUSTODL COSTS	MAJOR REPAIR & REPLACE-MENT COSTS	OTH O&M COSTS & MONETARY BENEFITS	DISPOSAL COSTS OR RETENTN VALUE	TOTAL
A	119	567	2575	0	0	0	3262
B	2898	146	1383	0	0	0	4427

TABLE II. LIFE CYCLE COST COMPARISON (ACTUAL NET PW VALUES)*

++ INCLUDES PRE-BOD COSTS, IF ANY

Figure 2. LCCID Output.

LIFE CYCLE COST ANALYSIS STUDY: KNOX

LCCID 1.035 DATE/TIME: 08-16-89 11:25:41

PROJECT NO., FY, & TITLE: P000 FY 89 HEAT RECOVERY INCINERATOR

INSTALLATION & LOCATION: FT. KNOX KENTUCKY

DESIGN FEATURE: ALTERNATIVE EVALUATION

NAME OF DESIGNER: GRIGGS

SUMMARY REPORT

ALT ID.	INITIAL INVEST-MENT COSTS++	ENERGY COSTS	RECURNG M&R & CUSTODL COSTS	MAJOR REPAIR & REPLACE-MENT COSTS	OTH O&M COSTS & MONETARY BENEFITS	DISPOSAL COSTS OR RETENTN VALUE	TOTAL	SIR	DPP
A	BASELINE ALTERNATIVE: ALTERNATIVE LOWEST IN INITIAL INVESTMENT COST								
B	2779	-422	-1192	0	0	0	1165	.6	>99

TABLE III.A INCREMENTAL LIFE CYCLE COSTS* (RELATIVE TO BASELINE)

++ INCLUDES PRE-BOD COSTS, IF ANY

*NET PW EQUIVALENTS ON AUG89; IN 10**3 DOLLARS; IN CONSTANT AUG89 DOLLARS

Figure 2. (Cont'd).

is made to enter data outside the technically valid range of HRIFEAS, the program will abort and write a message to the screen, advising you to seek technical assistance. If user-supplied data values exceed reasonable limits, the program will use the data if the user so indicates, but will flag the data as suspect.

HRIFEAS is intended to help analyze potential HRI projects at Army installations. The program can analyze other services' installations through the "OTHER" option, accessed by entering "Other" when prompted for the name of the installation. Note that the LCCID program is set to perform the economic analysis based on Military Construction, Army (MCA) project financing. It is possible to skip the economic analysis and perform only the technical and cost-estimating analysis for these additional cases. Another option allows previous data to be retained (not overwritten) and/or read from a specified file.

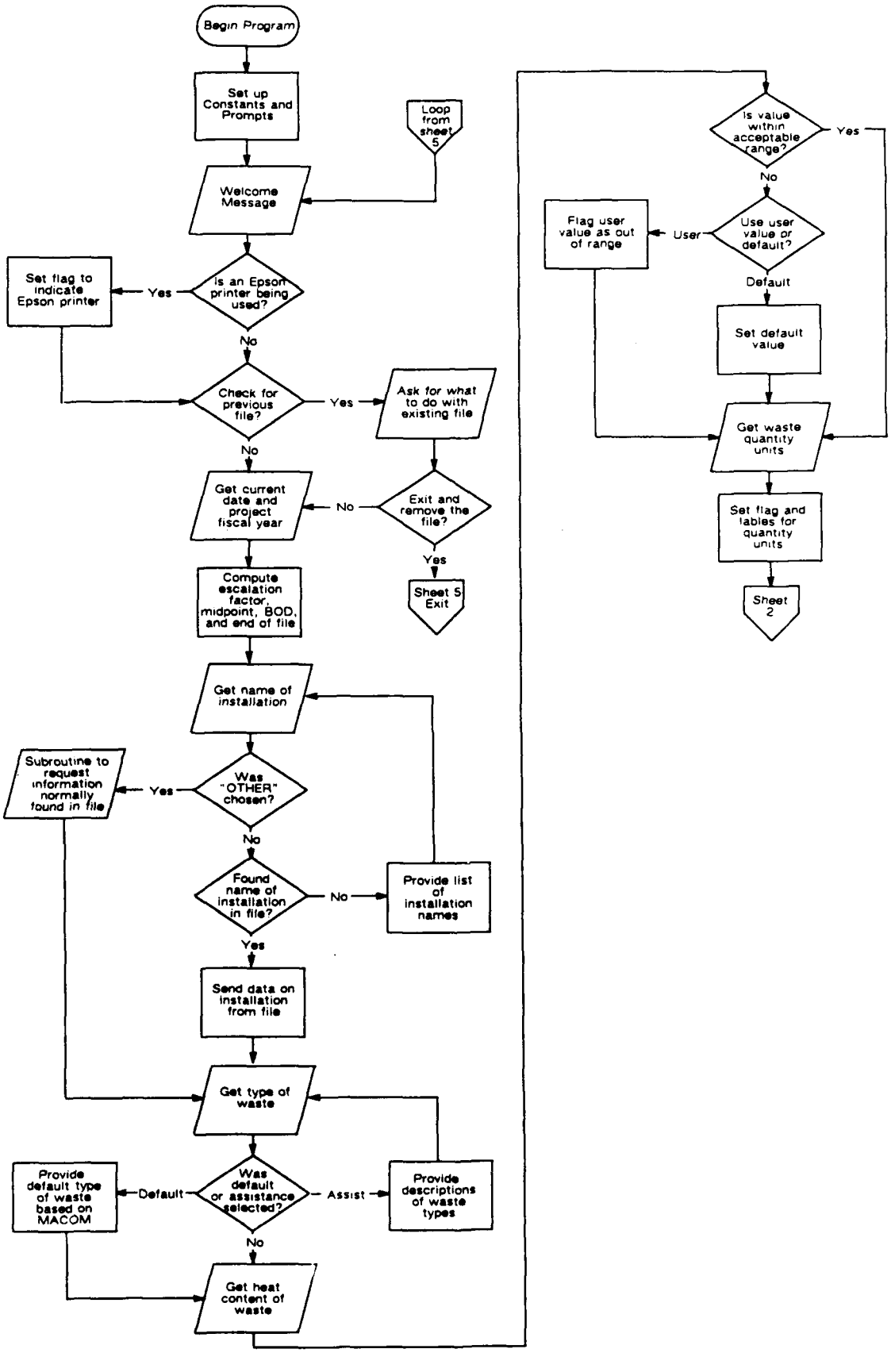

Figure 3. HRIFEAS Flow Diagram.

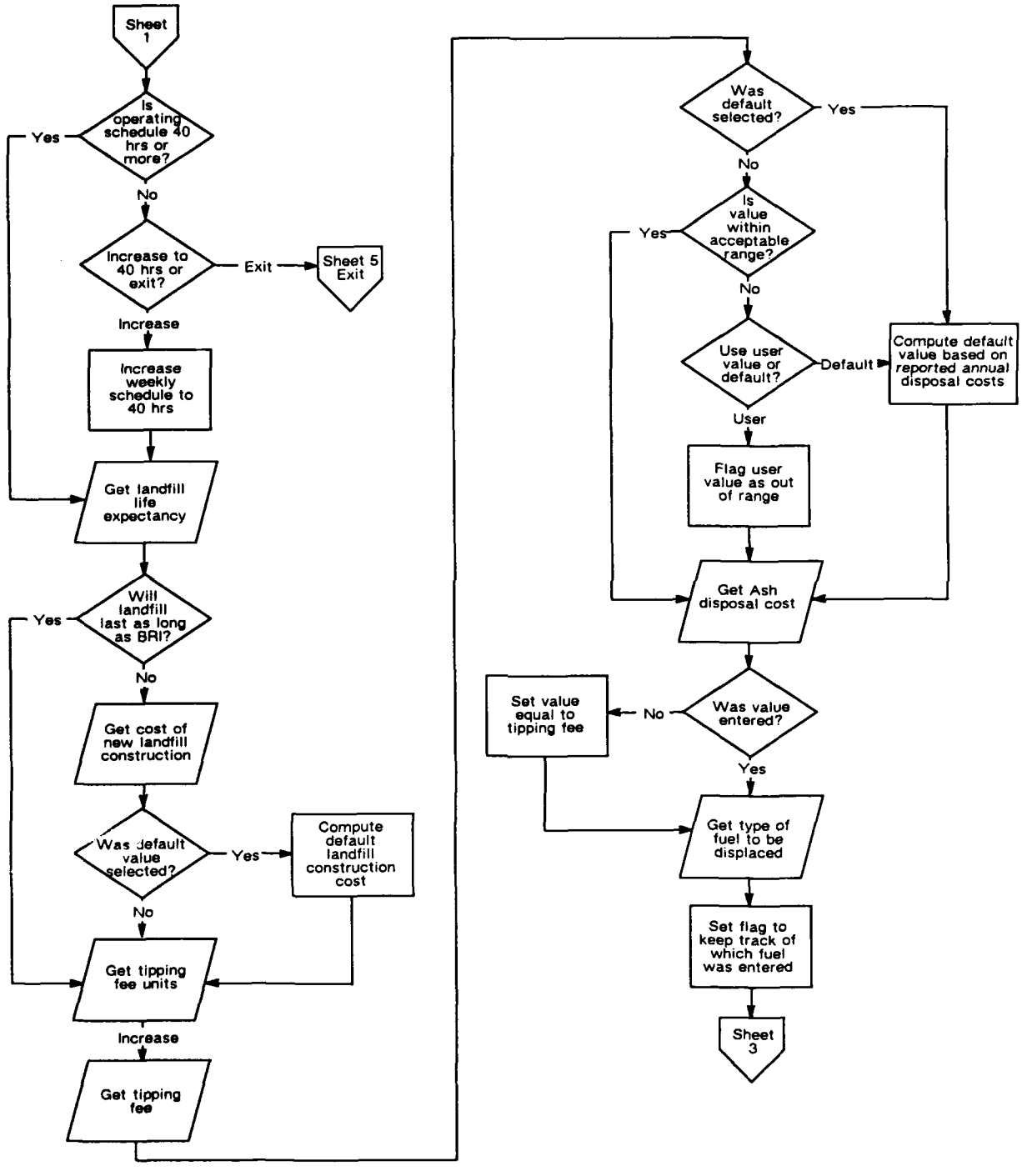

Figure 3. (Cont'd).

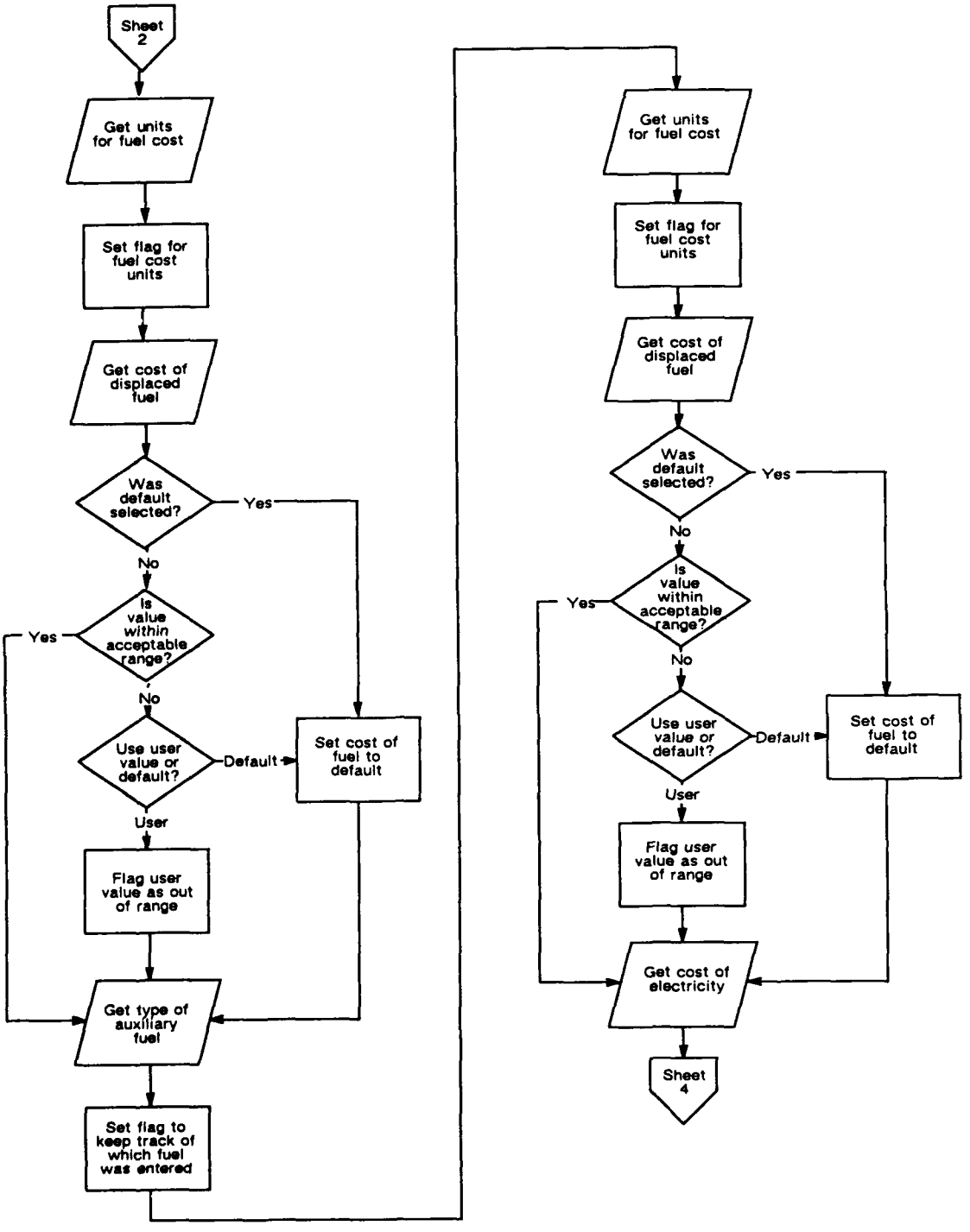

Figure 3. (Cont'd).

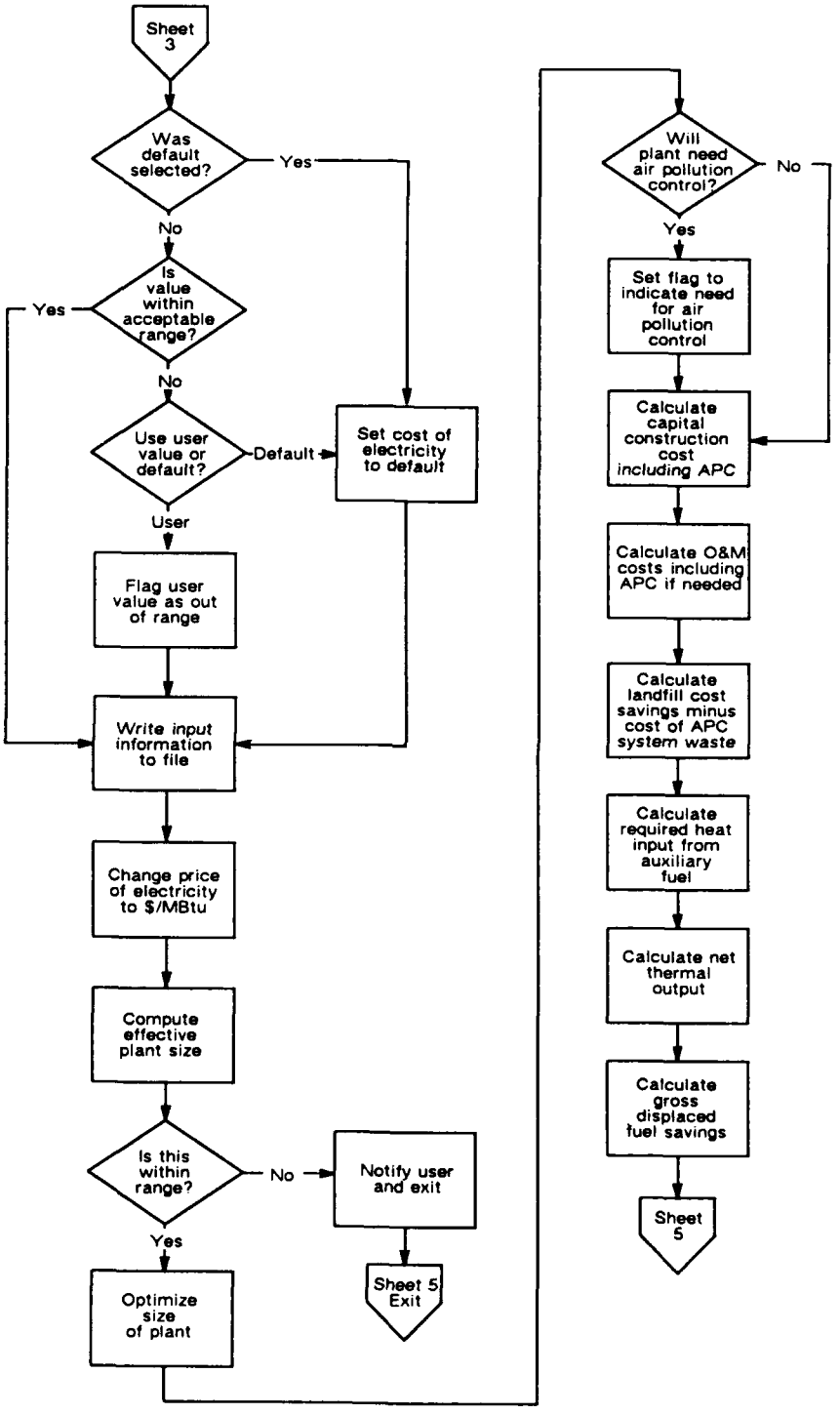

Figure 3. (Cont'd).

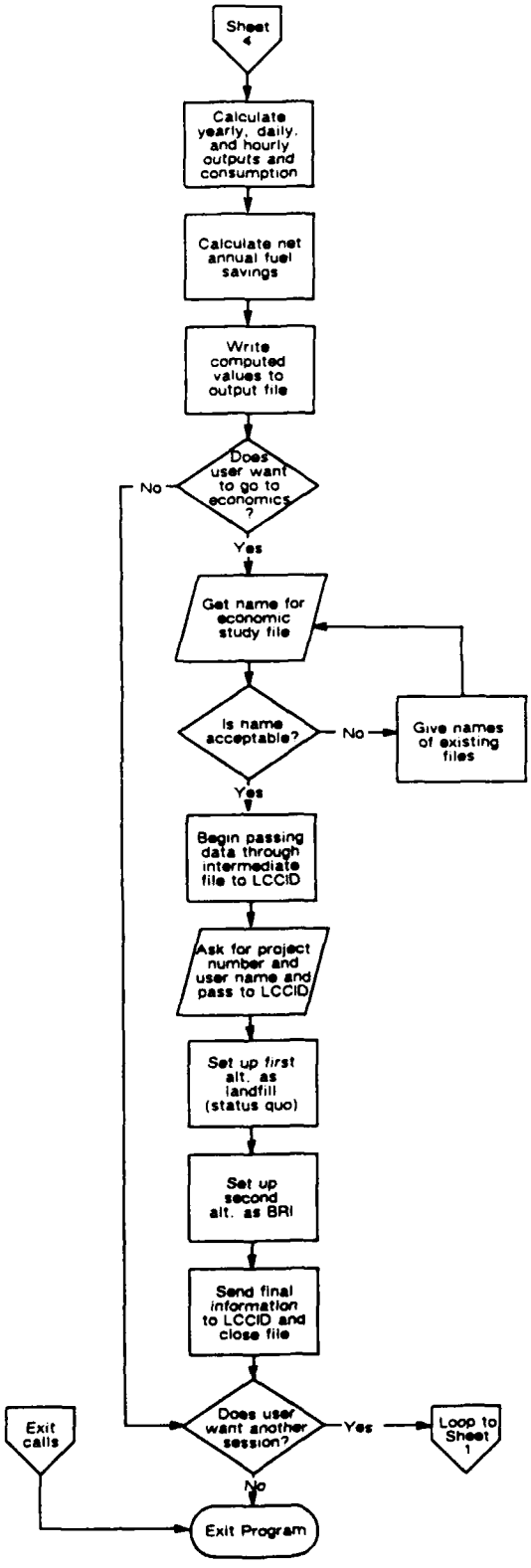

Figure 3. (Cont'd).

3 HRIFEAS CODE

Program Initialization

The program first initializes some important variable names and some constants used in the calculations. Certain user prompts and labels that are used repeatedly are assigned to variables to reduce the total size of the code. Certain flags are initialized as a blank. A statement also sets color screens to a blue background and yellow foreground. This setting has no apparent effect on a monochrome screen. Future revisions of this program could include a more complex use of colors.

The user sees a welcome screen and a statement concerning the limitations of the technical validity of the program, use of scrubbers, and energy cost defaults. Routine administrative notices are given, e.g., to exit the program, type (upper or lower case) QUIT. The user is asked whether or not the computer is set up to use an Epson printer requiring special codes to produce the cent [¢] sign). Each input is checked for a proper response; an error message is given for any response with an initial character other than an (upper or lower case) Y/N. The question repeats until an acceptable response is given.

The current date is requested since not all microcomputers have clocks. This value is used to escalate certain costs from the starting date to the current year. The date is also checked for validity (e.g., for the presence of the "/"). Invalid responses invoke an error message, and the question is repeated. The program then calculates a numeric equivalent for the date and an escalation (inflation) factor to be applied to the construction capital cost. The inflation factor is based on indices published in the Engineering Improvement Recommendation System (EIRS) bulletin by the HQUSACE Directorate of Military

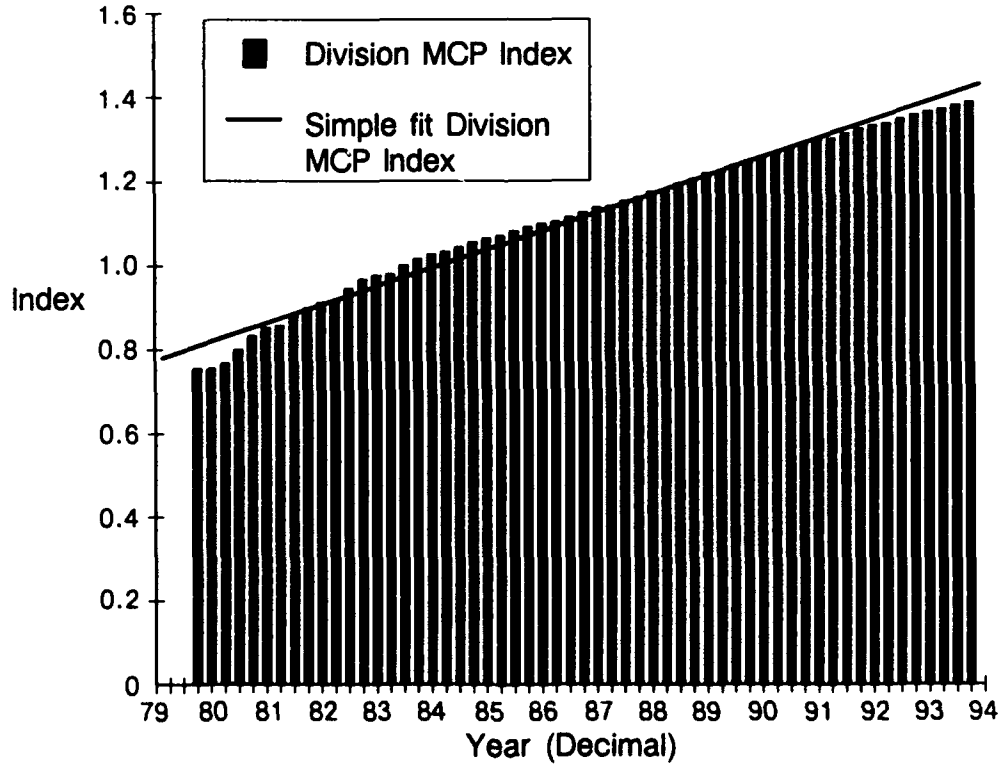

Figure 4. Construction cost inflation index.

Programs over several years. Figure 4 shows a graph of this data relative to the base year of 1983, and the straight-line equation fit to the data. The equation developed has a correlation factor of 0.9915 (where a perfect fit equals 1.0) and allows the estimation of future inflation. A similar inflation factor for the operations and maintenance (O&M) costs is also calculated based on the "Marshall & Swift Equipment Cost Index" published in *Chemical Engineering* magazine.

Next, the user is given an opportunity to read in data from the output file of a previous session. If "yes" is selected, the program jumps to a section of code beginning at statement 500. The full name of the file must be given, including the session number extension. The program then reads and decodes the file for the input information. The program moves to the section of the program, beginning at statement 205, that facilitates the changing of selected inputs. The session number is given, in either case, for multiple design (sensitivity) analyses.

At this point, the user is asked for a file-name to use for the HRIFEAS and LCCID output files. The response given can be any five characters that will help the user identify the files. "HRI" is not allowed as a file name to avoid confusion with the batch file of that name (on a hard disk system) that controls program execution. The program then checks for the existence of a previous file of the form XXXXX.##, where ## stands for the session number. If the file exists, the user may either exit and change the name of the file, or overwrite the existing file. Instructions for properly renaming files are given. On request, all existing HRIFEAS output files can be listed.

Once a fiscal year is entered, the program checks for a valid entry. This number is then used to calculate the midpoint of construction (M$), beneficial occupancy date (BOD$), and the economic end of life (eol) based on an assumed construction start date of March of the following year, and a 2-year construction period.

A file called NAMES.I contains the name, state, Major Army Command (MACOM), U.S. Department of Energy (DOE) Region, effective population, and annual refuse disposal cost of every Army installation. The last two values are taken from the Corps of Engineers "Red Book."* Revisions to HRIFEAS will periodically update this file from the latest edition of the Red Book. The program opens this file and asks for the name of the installation to analyze. To analyze a location other than an Army installation, enter "Other." Otherwise, the name or a partial name of an Army installation may be entered. A case-independent substring search is made for the name field of each record in the file to identify the correct record. For each one found, the program asks you to confirm it as correct. Note that the name of one post could be a substring of the name of another; for example Fort Ord appears in Fort Gordon. If the selection is not correct, the user is given may re-enter a more complete or distinctive name. If the selection is confirmed, the installation data is read. If the installation cannot be found, the program asks if a listing of the names of the posts is desired to choose a correct name and spelling. The listing is given one section at a time, and the correct name may be re-entered. If "OTHER" was chosen instead of an installation name, a subroutine requests the data that would have been read from the file. This data is used to error-check information concerning waste generation rates and disposal costs. At the end of this section of code, the NAMES.I file is closed and not used again.

* The "Red Book" is the common name applied to the *Facilities Engineering Annual Summary of Operations* (U.S. Army Engineering and Housing Support Center [USAEHSC], Fort Belvoir, VA).

Prompt for Number and Type of Waste

The program prompts for the number of the type of waste that will be burned. These values are based on the Incinerator Institute of America (IIA) Standards. Although the IIA itself no longer exists, these standards are still widely used. The user may request the default value, based on the particular MACOM type of facility, by entering "?". Pressing <enter> will cause a description of the IIA waste types to be listed from the HELP1.I file, one portion at a time. The value for waste type is also checked for validity. If the default waste type is assigned, the program asks if that value is acceptable; if it is not, another value may be entered. After the waste type has been established, the user is asked to provide the heat content of the waste. Default values are available, based on the waste type. The user input is checked for credibility based on whether it falls within ± 25 percent of the default value. If the entry is outside of this range, the program asks whether to keep the value or enter a new one. If the user decides to keep an out-of-range value, the program will use that value, but will also set a flag to mark the value, in the output, as being suspect.

Prompt for Waste Units and Amount

In the next step, the program prompts you to enter the units of measure and the actual amount of waste. HRIFEAS lists the units for both weight and volume. In the units-per-day options, two variations are given, to reflect whether the waste is picked up on a 5- or 7-day-per-week basis. The entry is checked for validity and an error message given if it is not. A subroutine sets the proper label for the waste quantity based on the entry. If the user selected the "don't know" option, the units are set to tons per year. The user is then asked for the waste quantity based on the selected units. If the default value is selected, the waste quantity units are changed to tons per week (TPW) and a value is calculated based on the effective base population and the USEPA maximum generation rate of 5 lb* per person per day over 7 days. If a number is entered, it is converted to tons per week and compared to the default value. If the user-supplied number varies by more than ± 25 percent from the default value, the user is notified and asked whether to keep the entered value or use the default. If the user decides to keep an out-of-range value, the program will use that value, but a flag is set that will mark the value, in the output, as being suspect. Conversion from volumetric values to weight values is done based on the typical densities of the various types of waste based on the IIA standards.

Operating Schedule Requested

The operating schedule of the proposed incinerator plant is requested in terms of days per week and shifts per day. If the total is less than 40 hours per week, an error message is generated and the user may either change the operating schedule or abort the program. Due to the gross inefficiency of operating a plant less than 40 hours per week, the program will not accept anything less. Error checking is also done on the entries to ensure that sound values are entered; e.g., the program will accept no more than three shifts per day.

The next part of the program requests information on the landfill life expectancy and replacement cost. After the user inputs the life expectancy of the landfill in years, the program compares the economic life of the landfill to that of the incinerator plant. If the landfill (without the HRI) would have closed before the end of the life of the HRI, costs for the remaining number of years of required landfill life are calculated as if HRI and landfill lives were equal. If the landfill would have lasted longer than the HRI

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*1 lb = 0.4536 kg.

plant without the HRI being constructed, the calculations are similarly adjusted. These adjustments allow both alternatives to have equal lives for economic comparison purposes. If the landfill would have lasted longer than the expected life of the HRI, then the landfill option is given a salvage credit. The user is then asked for the capital cost associated with building a new landfill with that number of years of life. If the landfill will last longer than the incinerator plant, this question is skipped, the landfill replacement capital cost (repcc) is taken as zero, and a salvage value is calculated. If the user does not provide a value, a default capital construction cost can be selected and calculated by the program. The default value is based on a rough estimate of $15/ton.[3] This value is multiplied by the number of tons that would need to go into the new landfill for the calculated time duration. The user is notified of the default value and if it is not acceptable, another value may be substituted.

The user is then asked for the landfill disposal costs, which is composed of the tipping fee plus any transportation costs. This should not include the collection costs, which are independent of the method of disposal. The user is first asked to choose between volumetric or weight units. If the "don't know" option is selected, weight units are selected by default. The value of the waste disposal costs is then requested. A default value is based on the amount of waste entered earlier and the annual disposal cost from the NAMES.I file. If the disposal cost entered varies by more than ± 25 percent from the default value, the person asks whether to keep the value or use the default value. If the user decides to keep a value that is out of range, the program will use that value, but a flag is set that will mark the value, in the output, as being suspect. Conversion from volumetric values to weight values for subsequent calculations is done based on the typical densities of the various types of waste based on the IIA standards. If the default value is selected, the user is notified of the value and is given the choice to either use it or enter a new value.

In many regions, the ash disposal cost will differ from the cost of waste disposal due to requirements for a separate ash landfill (monofill). Therefore the user is asked for an ash disposal cost if it is different. Any non-numeric entry will set the value equal to the waste disposal cost. If this value is not acceptable, the program loops back and asks that the value be re-entered.

Fuel Information

HRIFEAS then prompts for information on the fuel to be displaced by the heat generated by the HRI plant. The user is first presented with a list of forms of energy to choose from. Coal is not included in the list since it is so inexpensive on a $/MBtu basis that it is difficult to economically justify a plant on that basis. The input is checked to ensure its validity. If the "don't know" option is selected, the program assumes the fuel to be natural gas. A flag (dftyp) is set to keep track of the selected fuel and a subroutine selects the correct label. The subroutine also asks whether the fuel cost will be entered in terms of $/MBtu or $/unit of measure. Cost per unit of measure is the default. A default value for fuel cost is available based on information from the USDOE for each region from either the FUEL1.I or the FUEL2.I files, based on the units selected. If the default value is selected, the user is notified of the value, and may either use it or enter a new value. If the entered cost varies by more than ± 25 percent from the default value, the program asks whether to keep the value or use the default. If the user confirms an out-of-range value, the program will use that value, but a flag is set to mark the value in the output as being suspect. Another flag is also set to mark the default value that must be confirmed, if that was selected.

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[3] Personal communication, Mr. L. Hickman, of the Government Refuse Collection and Disposal Association (April 1986); Robert T. Glebs, "Landfill Costs Continue to Rise," *Waste Age* (March 1988), pp 84-93.

The program then prompts for information on the auxiliary fuel in the incinerator's burners that will start the unit and supplement the heat released from the waste, when necessary. The user may select a fuel from a short list of forms of energy appropriate for use as auxiliary fuel. The input is checked to ensure it is valid. If the "don't know" option is selected, the program again assumes natural gas. A flag (aftyp) is set to keep track of what fuel was selected and the same subroutine as above selects the correct label. Auxiliary fuel information is processed the same as displaced fuel information.

Price of Electricity

The program then asks for the price of electricity in cents per kilowatt-hour (KWh). By entering "?", the user may request the default value for electrical cost based on information from USDOC for each region from either the FUEL 1.I or the FUEL2.I files. The input is checked to ensure it is valid. If the default value is selected, the user is notified of the value and may either use it or enter a new value. If the entered cost varies by more than ± 25 percent from the default, the program asks whether to keep the value or use the default. If the user decides to keep an out-of-range value, the program will use that value, but will set a flag to mark the value, in the output, as suspect. If the default value was selected, it will be marked as such to indicate the value must be confirmed.

At this point, the basic technical information is complete. Before proceeding with the calculations and requesting additional information required for the LCCID program, HRIFEAS writes a file containing a table summarizing the input information. This is done at this time so that, in the event of an abort, the user may print out this file to find the cause of the abort. If a flag has been set to indicate an input value that is suspected to be out of range, an asterisk is printed to the left of the label for that value. For defaults, a pound sign (#) is printed to remind the user that this value must be checked. Otherwise there is a blank between the label and the left hand border, and borders of dashes and vertical pipes (|) surround the information. Notes at the bottom of the table clarify symbols and abbreviations. The resulting file is labeled "XXXXX.##" where ## is the session number and XXXXX is the study name given by the user.

The first calculation HRIFEAS performs converts the price of electricity from cents per KWh to dollars per MBtu. This is required for interfacing with the LCCID program, and to show relative costs of the forms of energy used. The program then computes the effective plant size based on the amount of waste to be burned each week and the proposed operating schedule. This value is then checked to see if it is within the program's valid range. If it is not, the user is notified with an explanatory message, instructed to call USACERL for technical assistance, and the program terminates itself.

Plant Size

If the effective size of the plant in terms of the daily amount of waste to be burned is acceptable, the program then begins to optimize the actual plant size. This is based on the plant consisting of two, three, or four units. One unit is assumed to be a spare, and the unit sizes are calculated in multiples of 5-tons-per-day capacity. This section of code computes the size of each incinerator required to burn all of the waste with one, two, or three units. The unit size is then rounded up to the next multiple of 5 tons per day. The program then determines the optimal combination of unit size and number of units that produces the smallest total plant size (including one redundant unit), and therefore incurs the smallest installed plant cost.

It is anticipated that the 1990 Clean Air Act amendments will require HRIs covered by this program to be equipped with acid-gas-scrubbing or particulate-removal air pollution control equipment.[4] The program calculates the additional capital and operating costs for this based on a dry-lime injection system. The program could also assume a wet-scrubbing system, but wet systems sometimes have less reliable performance due to chemical carry-over if excessive amounts of mist are emitted.

Capital Construction Cost

The program then begins to calculate the capital construction cost. HRIFEAS calculates the basic construction cost of the plant in dollars per ton per day of installed capacity. This algorithm is based on analytical work done both in-house and by Argonne National Laboratory for USACERL.[5] The data on existing incinerator plants showed a high degree of dispersion and this equation represents the best curve fit possible. The construction cost of the air pollution control equipment in dollars per ton per day of installed capacity is based on cost estimates provided by a manufacturer of dry-lime injection equipment.* The capital and operating-cost information obtained from the manufacturer is illustrated graphically in Appendix B, which also shows including the curves fit to the data. A wet-packed tower system would cost a little less, but a spray-dry system would be so expensive that it cannot be justified for this size range of incinerators. The inflation factor calculated near the start of the program updates these numbers from 1983 to present-year dollars. The total construction cost is calculated by combining these two numbers and multiplying by the total installed plant capacity.

Operation and Maintenance Cost

The O&M cost for the incinerator plant itself, in terms of dollars per ton of waste processed, is also based on analytical work done both by USACERL and by Argonne National Laboratory for USACERL. Data was limited since most incinerator plants do not track O&M costs less the cost of energy consumed (electricity and auxiliary fuel). Therefore, this cost component is again a best estimate. The component representing the cost of operating the air pollution control equipment is based on cost estimates provided by a manufacturer of dry-lime injection equipment (Appendix B). The total annual O&M costs then calculated by multiplying this combined value by the total amount of waste processed each year, based on 52 weeks per year. The resulting value in 1983 dollars is then converted to current-year dollars. The one redundant unit should allow the plant to maintain the full "rated" capacity at all times.

Landfill Savings

The next section of code calculates the landfill savings. First, the program checks to make sure the landfill disposal costs are expressed in dollars per ton. If not, the program converts the dollar per volume amount based on the typical density of the various waste types. The annual landfill savings (ls) are calculated based on a 60 percent reduction in the weight of the waste (40 percent remaining) minus the cost of disposing of any scrubber effluent. This last component is again based on estimates provided by a manufacturer of dry-lime injection equipment. The calculation allows the ash disposal cost to be different from the cost of disposing of the raw waste.

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[4] *National Energy Strategy*, Interim Report DOE/S-0066P (Department of Energy [DOE], April 1990).

[5] Hub et al., *Information and Approaches Involved With the Evaluation of Heat Recovery Incineration Applications* (Argonne National Laboratory, April 1984).

* Interel Corp., P.O. Box 4676-T, Englewood, CO 80155.

Auxiliary Fuel Requirement

The program then computes how much auxiliary fuel is needed. An equation was developed by Argonne National Laboratory to give the auxiliary heat input required per ton of waste processed (mbton) based on the operating schedule, which gives the frequency of start-ups, a large consumer of fuel. The total annual amount of heat needed, in MBtus, is then determined by multiplying this value by the annual amount of waste processed. The program checks the units for the cost of the auxiliary fuel and converts to $/MBtu if necessary. The annual auxiliary heat requirement is then multiplied by the fuel cost to produce the annual auxiliary fuel cost.

Thermal Output

Next, the thermal output is calculated in several forms. The annual amount of useful heat production (HP) in MBtu is calculated based on the total amount of waste burned, the heat content of the waste, plus the amount of heat from the auxiliary fuel, and an assumed 50 percent thermal efficiency. This thermal efficiency is considered by USACERL to be a realistic number for a well-operating Starved Air or Controlled Air incinerator with a separate heat-recovery boiler. Other technologies that use a more vigorous combustion process with an integral boiler can produce much higher thermal efficiencies, but will have increased air pollution problems. The program checks the units for the cost of the displaced fuel and converts to $/MBtu if necessary. The program then calculates the gross displaced fuel savings (GFS) based on the HP, the displaced fuel cost, and the expected efficiency of a boiler burning that fuel. The yearly steam production is computed based on the annual HP and an assumption of approximately 1000 Btu/lb of steam. Daily and hourly steam production rates are also calculated with an allowance on the hourly rate for warming up the boiler for one- or two-shift operations. Other yearly, daily, and hourly values are calculated for auxiliary fuel consumption, displaced fuel quantities, hours the plant is operational, and amount of waste disposed of by weight and volume. Annual electrical energy consumption and cost is computed based on a formula that includes the additional electricity of air pollution control equipment. The auxiliary fuel and electrical costs are subtracted from the gross fuel savings to determine the net annual fuel savings.

Printout of Computer Values

The next section of code prints these computed values, with appropriate labels, to the XXXXX.## file. The last bit of coding before the file is closed resets the printer from the codes previously sent to print the cent sign. The file is then closed and the program begins preparing for the LCC.

The user first specifies whether to do the economic analysis and check the answer for validity. If the economic analysis is not done, this section of code is simply skipped. If the analysis is to be done, a file named "LCC_IN.___" is opened to store the information that must be passed to the LCCID program. An error trap is then set to detect if the LCC file name already exists. If the study name given previously already exists as an *.LC file, the user may choose another name, destroy the old file, or quit this section of the program. To help the user choose a unique name, the program uses a call to the operating system to list all of the existing LCC file names. The user is asked to select a name different from those listed. If the file is to be deleted, the user is first prompted to confirm the deletion. The error trap is then turned off and the program begins writing the LCCID input file. The user is then asked for certain information that must be passed to the LCCID program.

Certain administrative and standard information is first written to tell LCCID that instructions are not needed, it is a new study, it is an MCA project, energy is part of the project, inputs will be in

thousands of dollars and MBtu, and that the most recent energy price escalation table should be used. LCCID is also told what state the project is in, and the price of electricity, displaced fuel, and auxiliary fuel (even if both are the same) in terms of $/MBtu. The user is then asked for a project number (an arbitrary alphanumeric entry that is passed to LCCID for identification purposes only). The program then passes the fiscal year previously entered by the user, gives a project title of "Heat Recovery Incinerator," and gives the name of the installation that was also previously entered. The program then asks for the user's name (required by LCCID for study identification purposes only). The design feature is identified as "Alternative Evaluation" between continuing to landfill and constructing an HRI plant. The program then passes the current date, the date of the midpoint of construction, the BOD (computed as noted above), and an economic life of 15 years.[6] The next data passed to LCCID describes the two alternatives being evaluated.

The first alternative is the status quo, or continuing to landfill. The landfill savings that would be realized by operating an incinerator is passed as an O&M maintenance cost for the landfill option. If building an HRI would forestall new landfill construction until after the end of the economic life of the HRI being considered, the capital cost computed as noted above is passed instead of being entered as zero. If this cost would be incurred after the midpoint of construction of the HRI, a new date is computed and passed to LCCID. If the landfill would have lasted longer than the HRI life, a salvage value for the landfill is entered. Since LCCID requires entry of certain fuel energy consumption information, HRIFEAS enters a series of zero values, and later identifies the type and amount of fuel being displaced.

The second alternative is to construct the HRI plant. The constructed capital cost (including air pollution control) is given. After the electrical energy requirements are passed, a series of zero values are entered for fuel consumption as noted above. Then the actual value for auxiliary fuel type and consumption are given. The HRI O&M maintenance cost is given last.

Once both alternatives are defined, the program passes instructions for the life-cycle cost (LCC) calculation. The landfill is selected as the baseline option. Although this would normally be the automatic case, sometimes a new landfill will actually have a higher capital cost than a new HRI. A comparative report is requested instead of detailed individual reports since it gives the essential information for making an economic selection. Sending the report to the screen and/or directly to the printer is not selected. The LCCID program is told to send the report to a print file with the same basic name as the study file, which can be printed out later. LCCID is also told to make the comparison of the HRI option with the landfill baseline, print the computed discounted payback period (DPP) in years, without the detailed DPP and savings to investment ratio (SIR) calculations. A couple of carriage returns to cause LCCID to exit completes the input file and it is then closed.

If the user elects not to perform the economic analysis, the above described code is skipped. The user is then notified that the basic part of the program is finished and the results have been saved to a file called XXXXX.##. The user is asked whether to print results to the screen, a screen at a time using the system "MORE" utility. If another session is desired, the program allows the previously entered values to remain and asks if the user would like to change some values. If a value is to be changed, a special flag is set. The program loops back to the section of code requesting those values, and after new values are entered, returns to the next line of code after the line that transferred to it. Such additional sessions are useful to the user doing a parametric study of variations in costs, and/or unit size. However, the option for another session is skipped if the user elected to do the economic evaluation since there is no provision at this time to do more than one economic evaluation per start of HRIFEAS. The LCCID

[6] K.E. Griggs, G.A. Chamberlin, R.A. Ducey, and G.W. Schanche, *Characteristics of Incinerators With Heat Recovery Capability*, TR E-88/04/ADA194537 (USACERL, April 1988).

program is started and run after HRIFEAS terminates. HRIFEAS terminates by jumping to statement 999, which issues a goodbye message and executes a normal end.

The remaining code consists of a series of subroutines that either may or may not be called, or are called several times as subroutines that minimize duplication of code. The first (line 620) sets up the codes needed by Epson printers to print the cent sign. The next subroutine (line 1170) provides help with the two letter abbreviations of the states. The following routine (line 800) is called when the "OTHER" option for the name of the post is given, to ask for the information normally found in the NAMES.I file, and to figure what the DOE region is based on the state. The next routine is one of the error traps. The next routine (line 990) specifically looks up the DOE table value of regional electrical cost to compare with the user input. The next routine (line 991) completes getting information on the displaced and auxiliary fuels including reading the regional table values from the appropriate file based on the user input units. The next two routines (lines 996 and 997) set the correct labels for the waste disposal costs and generation rates. The following routine (line 998) is the other error trap. The last routine at 999 is the exit from the HRIFEAS program.

4 SUPPORTING BATCH FILES

The HRIFEAS and LCCID programs are started and linked together by a batch file. When run from two floppy disks, this link is part of the AUTOEXEC.BAT file, which is automatically executed by DOS when the computer is first turned on. When installed on a hard disk, a very similar file exists in the C:\HRI subdirectory, called HRI.BAT. The AUTOEXEC.BAT file contains an option and instructions for starting the HDINST.BAT file to install the software and run it from a hard disk. A command is issued to remind the computer where the COMMAND.COM file is located. If an LCC_IN. file (containing input for LCCID) already exists, it is erased to avoid an accidental execution resulting from failure to write a new file. The HRIFEAS program is then loaded and executed. When it finishes, the batch file resumes, loads, and executes LCCID if a new LCC_IN. file exists. If it does not, the batch file terminates. Prior to beginning LCCID, a message is printed on the screen informing the user that the life cycle costs are being computed. The LCCID program is started by the batch file that inputs LCC_IN. to LCCID and sends the normal screen output to a file called TEMP. This way, the operation of LCCID is totally automatic and transparent to the user. The LCCID program will normally take anywhere from 2 to 4 minutes to run, depending on the speed of the computer. At its conclusion, the batch file informs the user that the analysis is complete and that reports can be printed from the appropriate drive, and then ends. To restart HRIFEAS, it is necessary to either reboot or type AUTOEXEC from a two-floppy system, or to type HRI from a hard-disk system. These files and the other batch files described in the following paragraphs are listed in Appendix A.

The LCCID program itself needs two system- or installation-specific files to run properly, "F$FND.___" and "LCCID.INI". These two files are normally generated by running the LCCID installation program. For the convenience of the user, these files are included on the two HRIFEAS floppy disks, along with two other files for hard-disk installation. These files provide path names to direct LCCID file access and identify the economic evaluation factor file. Text copies of these files are also included in Appendix A. *Additional noninstallation-specific data files are also needed by LCCID.*

The HDINST.BAT program provides an automated procedure for properly installing HRIFEAS, LCCID, and supporting files onto a hard disk. The batch file assumes minimal computer knowledge on the part of the user, that the hard disk is labeled C:, and that there is sufficient room on the disk for the files. The user is given instructions on what the batch file will do and told to press CTRL and C to abort the program if that is not acceptable. Once begun, the program creates a subdirectory called C:\HRI and copies the necessary files from the A: drive to that subdirectory. Three of the files are renamed as they are copies onto the hard disk. The text contents of these files are also listed in Appendix A. Since disks must be switched for a single-floppy machine, a file called HD.BAT is also copied to the hard disk and execution is transferred to that batch file. This file first instructs the user to switch to the B: disk in the floppy disk drive. It then copies the only relevant file (LCCID.EXE) to the hard disk. HD.BAT then notifies the user that installation is now complete and the program may be started by typing "HRI". This batch file then erases itself. No changes are made to the original floppy disks. The software may be installed on as many hard disk machines as desired, and it may also be locally reproduced. If an installation other than that described above is desired, special assistance must be obtained from USACERL.

5 CONCLUSIONS AND RECOMMENDATIONS

An initial version of the HRIFEAS program was developed as an "expert system" to conduct screening studies for potential HRI projects. This program should greatly shorten the time and reduce the expense of bringing an Army HRI project from initial planning to the point of bidding for construction.

The current estimate of landfill construction cost is a "best guess" based on professional estimates. It is recommended that studies should be done to determine the capital construction costs of landfill designs typical of Army installations. USACERL analysis shows that HRI plants that provide the greatest payback are those that displace the most years of new landfill construction.

The Argonne National Laboratory and studies done for the Navy cited wide variations in capital construction costs for HRIs, and little data was found to document operating costs. It is recommended that additional analysis be done to refine and improve the cost estimates, including regional variations in construction cost.

Several changes are recommended to be made to the HRIFEAS program code. The program should be modified to perform multiple LCCID runs without completely restarting the batch files and HRIFEAS. Improvements should be made in the use of color to make the program more visually appealing on a color screen. Future user comments should be incorporated to ensure maximum ease of use.

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APPENDIX A: HRIFEAS Source Code and Batch Files

HRIFEAS Source Code:

```
    rem -----initialize some variables-----
    rem
    rem  dftyp=displaced fuel type  dfunit=fuel units  dfcst=fuel cost
dflg=flag
    rem  aftyp=auxiliary fuel type  afunit=fuel units  afcst=fuel cost
aflg=flag
    rem
    dim f(5),f$(5),fcun$(5),fcnv(5),erf(5)
    f$(4)="natural gas": f$(5)="liquid propane gas": f$(2)="distillate
oil": f$(3)="residual oil": f$(1)="electricity"
    fcun$(4)="Kcuft": fcun$(5)="gallons": fcun$(2)="gallons": fcun$(3-
)="gallons": fcun$(1)="KWh"
    fcnv(4)=1.031: fcnv(5)=0.095: fcnv(2)=0.1307: fcnv(3)=0.14969:
fcnv(1)=0.003412
    erf(4)=0.87: erf(5)=0.87: erf(2)=0.85: erf(3)=0.80: erf(1)=0.95
    kwmbt=2.930: repcc=0.0: s%=0
    hcflg$=" ": wqflg$=" ": lfcflg$=" ": dflg$=" ": aflg$=" ": eflg$="
"
    r1$="  Response must be either Yes or No."
    r2$="  Is this correct (Yes or No)?:"
    r3$=" Invalid Entry."
    r4$="  Do you still want to use your value (Yes or No)?:"
    r5$="  Value given differs significantly from "
    r6$="  Is this value acceptable (Yes or No)?: "
    rem  ------Sets Background Color to Blue with Yellow Letters------
    color 14,1
    print chr$(12):                              rem  ---Clear the Screen
    s$=string$(72,61)
    rem
    rem  -----INTRODUCTION-----
    rem
    print s$
    print " Welcome to the Heat Recovery Incinerator Feasibility
Model"
    print s$;chr$(10)
    print: print " This program is based on Starved or Controlled Air
Incinerators"
    print " with a minimum size range limitation of 10 TPD (7 day
week)"
    print " and a maximum size limitation of 200 TPD (7 day week).":
print
    print: print " Pursuant to the Clean Air Act of 1990, all analyses
performed by"
    print " this program will include totally dry lime flue gas
scrubbers"
    print " for each incineration unit."
    print: print " Default fuel values are based upon FY91 data."
    print " Actual values for gas and electricity may vary."
    print: print " You may type <quit> at any time to leave the
program."
  2 print: print: input " Are you using an Epson FX printer (Y/N)?:"-
,pf$
    if ucase$(pf$)="QUIT" goto 999
    pf$=left$(pf$,1)
    pf$=ucase$(pf$)
    if pf$<>"Y" and pf$<>"N" then print r1$: goto 2
    rem
```

```
    rem  -----Ask for current date-----
    rem
  3 print: input " Please enter current date as MM/YY ",in$
    if ucase$(in$)="QUIT" goto 999
    if len(in$)>5 or val(left$(in$,2))>12 or val(left$(in$,2))<1 or
val(right$(in$,2))<1 then print r3$: goto 3
    if mid$(in$,2,1)<>"/" and mid$(in$,3,1)<>"/" then print r3$: goto
3
    dte$=in$
    tdate=val(right$(in$,2))+val(left$(in$,2))/12.012
    rem  -----The 12.012 is used to handle round-off errors-----
    if tdate<50.0 then tdate=tdate+100
    rem  -----Inflation Factor for Capital Cost-------
    cinf=0.04273478*tdate-2.59489
    rem  -----Inflation Factor for O&M Cost------
    ominf=0.01726*(1900+tdate)-33.2256
  4 print: input " Do you desire to load a previous file for addition-
al sessions (Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" goto 500
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 4
    rn%=1
  5 delay 2
    print chr$(12);" Session Number ";rn%
    rem  -----Set Error Trap and Check for Previous File-----
    on error goto 998
    i=len(str$(rn%))-1
    print: print " What is the study name?"
  6 print " Limit your answer to 5 (five) characters,"
    print " one of which must be alphabetic."
    input "  STUDY CODE: ",stdy$
  7 if ucase$(stdy$)="QUIT" goto 999
    if len(stdy$)>5 then print r3$: goto 6
    if ucase$(stdy$)="HRI" then print " HRI by itself is not an
allowable name.": goto 5
    f1$=stdy$+".0"+right$(str$(rn%),i)
    open "I",#1,f1$
    close #1
    rem  -----Give Options for File Name That Already Exists-----
  8 print: print " The study file, ";f1$;" from a previous session
already exists ..."
    print " Options:"
    print "  (1) Give a new name to your study."
    print "  (2) Quit HRIFEAS."
    print "  (3) Use filename that already exists, BUT existing file"
    print "  will be OVERWRITTEN and the contents will be destroyed."
    input " Type 1, 2, or 3:",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)<1 or val(in$)>3 then print r3$: print " Expecting a
value of 1 to 3.": goto 8
    if val(in$)=2 goto 999
    if val(in$)=3 goto 9
    delay 2: print chr$(12)
    rem  ---Use Operating System Call to List Existing Files-----
    print " List of existing files .... do not use when naming your
file."
    sh$="dir *.0??/w": shell sh$
    locate 23,1
    print " PLEASE NOTE the extension is automatically appended to all
file names."
```

```
    print " Enter a different study name."
    goto 6
    rem  -----Option to Delete Existing File with Given Name-----
  9 print: print " Are you sure you want to overwrite the file ";f1$;:
input " (Y/N)?: ",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 8
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 9
    sh$="del "+f1$
    shell sh$
 10 on error goto 0:                          rem -----turn off error
trap-----
    if s%=2 then s%=0: goto 530
    if s%=1 then s%=0: goto 200
 12 print: input " Enter the two-digit fiscal year for this project:
",in$
    if ucase$(in$)="QUIT" goto 999
    if len(in$)=2 and asc(left$(in$,1))>47 and asc(left$(in$,1))<58
and asc(right$(in$,1))>47 and asc(right$(in$,1))<58 goto 13
    print " Fiscal year must be a 2-digit integer."
    print " Please try again.": goto 12
 13 FY$=in$
    M$="03/"+RIGHT$(STR$(VAL(FY$)+1),2)
    BOD$="03/"+RIGHT$(STR$(VAL(FY$)+2),2)
    eol=val(FY$)+0.25+17
    if eol<50 then eol=eol+100
    if s%=1 then s%=0: goto 210
    rem
    rem  -----Identify which post-----
    rem
 15 open "I",#2,"names.i": post$=" ": state$=" ": macom$=" ": re-
gion=0: popu=0: refcost=0
    delay 2
    print chr$(12)
 16 print " Enter installation name or ";chr$(34);"OTHER";chr$(34);:
input ":",in$
    if ucase$(in$)="QUIT" goto 999
    if ucase$(in$)="OTHER" goto 800
 20 print " The installation you specified is: ";in$
    print r2$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" then input " Re-enter installation
name:",in$: goto 20
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 20
 30 if eof(2) goto 40
    input# 2,post$,state$,macom$,region,popu,refcost
    if instr(ucase$(post$),ucase$(in$) >0 goto 45
    goto 30
    rem
    rem  -----Give them some help to find the post-----
    rem
 40 print " Cannot match ";in$
 41 input " Would you like to see a list of installation names (Yes or
No)?:",in$
    if ucase$(in$)="QUIT" goto 999
    if left$(ucase$(in$),1)="N" then close #2: goto 15
    if left$(ucase$(in$),1)<>"Y" then print r1$: goto 41
    close #2: open "I",#2,"names.i"
 42 i=1
 43 input# 2, post$,state$,macom$,region,popu,refcost
```

```
    print post$: i=i+1
    if eof(2) goto 44
    if i<24 goto 43
    input " Press <S> to stop or any other key for more.",in$
    if ucase$(in$)="QUIT" goto 999
    if ucase$(in$)="S" goto 44
    goto 42
 44 close #2: open "I",#2,"names.i": goto 16
 45 print post$;" found.": close #2
    input " Is this the correct installation (Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" then print " Please make a more
complete entry such as Ft. XXX.": goto 15
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 45
    if s%=1 then s%=0: goto 215
    rem
    rem  -----Get waste type-----
    rem
 50 print: print: input " Enter waste type 0, 1, 2, 3, ? for default
or <cr> to see descriptions: ",in$
    if ucase$(in$)="QUIT" goto 999
    if in$="?" goto 54
    if in$<>"" goto 53
    open "I",#2,"HELP1.I"
 51 i=1: help$=" "
 52 input# 2,help$
    print help$: i=i+1
    if eof(2) goto 50
    if i<23 goto 52
    input " Press <return> for more.",in$
    if ucase$(in$)="QUIT" goto 999
    goto 51
 53 if val(in$)>=0 and val(in$)<4 then wastype=val(in$): goto 55
    rem  -----Set Default Waste Type-----
 54 if macom$="T" or macom$="F" or macom$="W" then wastype=2.0
    if macom$="H" or macom$="I" or macom$="M" then wastype=1.0
    if macom$="A" or macom$="C" then wastype=2.5
    print " Assigning a value of ";wastype;" for waste type"
    rem  -----Get the heat Content of the Waste-----
 55 print: print " Enter the heat content (in Btu/lb)"
    input " of the waste, else type ? : ",in$
    if ucase$(in$)="QUIT" goto 999
    if in$="?" goto 60
 56 print " You have specified a heat content of ";in$;" Btu/lb"
    print r2$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 55
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 56
    rem  -----Check for the Heat Content to be within Range-----
    if wastype=0 and val(in$)>7500 and val(in$)<9500 then heatcnt=val-
(in$): goto 65
    if wastype=1 and val(in$)>5500 and val(in$)<7500 then heatcnt=val-
(in$): goto 65
    if wastype=2.5 and val(in$)>4400 and val(in$)<6400 then heatcnt=v-
al(in$): goto 65
    if wastype=2 and val(in$)>3300 and val(in$)<5300 then heatcnt=val-
(in$): goto 65
    if wastype=3 and val(in$)>1500 and val(in$)<3500 then heatcnt=val-
(in$): goto 65
    print r5$;"the book value."
```

```
 57 print r4$;: input ,yn$
    if left$(ucase$(yn$),1)="Y" then heatcnt=val(in$): hcflg$="*":
goto 65
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 57
    rem  -----Set Default Values for the Waste Heat Content-----
 60 if wastype=0 then heatcnt=8500: goto 63
    if wastype=1 then heatcnt=6500: goto 63
    if wastype=2.5 then heatcnt=5400: goto 63
    if wastype=2 then heatcnt=4300: goto 63
    if wastype=3 then heatcnt=2500: goto 63
 63 print " Assigning a value of ";heatcnt;" Btu/lb"
 64 print r6$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 55
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 64
    rem
    rem  -----Get waste units and quantity-----
    rem
 65 if s%=1 then s%=0: goto 220
 66 delay 2
    print chr$(12)
    print " In which units do you wish to enter waste quantity?"
    print s$
    print " tpd (5 day)      1"
    print " tpd (7 day)      2"
    print " tpy              3"
    print " cuy/d (5 day)    4"
    print " cuy/d (7 day)    5"
    print " cuy/yr           6"
    print " don't know       7"
    input " Type 1, 2, 3, 4, 5, 6, or 7: ",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)<8 and val(in$)>0 then wqu=val(in$): goto 67
    print r3$: print " Expecting a value of 1 to 7":  goto 66
 67 gosub 997
    print: print " Enter waste quantity in terms of ";in$
    input " else type ? : ",in$
    if ucase$(in$)="QUIT" goto 999
    if in$="?" goto 70
    if val(in$)=0 then print " You must answer this ques-
tion.";chr$(13);" You may type ? if waste quantity is unknown.": goto
67
    wq=val(in$)
    gosub 997
 68 print " The waste quantity you have specified is: ";wq;" ";in$
    print r2$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" then print " Re-enter value": goto 67
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 68
    rem  -----Convert Waste Quantity into Tons per Week-----
 72 if wqu=1 or wqu=4 then TPW=wq*5
    if wqu=2 or wqu=5 then TPW=wq*7
    if wqu=3 or wqu=6 or wqu=7 then TPW=wq/52
    if wqu>3 and wastype<2 then TPW=TPW*9.0*27/2000
    if wqu>3 and (wastype=2 or wastype=2.5) then TPW=TPW*17.5*27/2000
    if wqu>3 and wastype=3 then TPW=TPW*32.5*27/2000
    if s%=2 then s%=0: goto 225
    if popu=0 goto 75
    rem  -----Check for Waste Quantity to be within Range-----
    if TPW>(0.75*popu*5*7/2000) and TPW<(1.25*popu*5*7/2000) goto 75
```

```
    print: print r5$;"value based upon population."
 69 print " Do you want to use:"
    print "    (1) computed value of ";: print using "####";popu*5*7/2-
000;: print " TPW"
    print "    (2) your value of ";: print using "######";wq;: print "
";in$
    print "        NOTE:  For your information, your value has been
converted and"
    print "        is equivalent to ";: print using "#####,";TPW;:
print " TPW"
    input " Type 1 or 2: ",yn$
    if ucase$(yn$)="QUIT" goto 999
    if yn$="1" then TPW=popu*5*7/2000: goto 75
    if yn$="2" then wqflg$="*": goto 75
    print r3$;"  Try again.": goto 69
    rem  -----Set Default Value for Wast Quantity-----
 70 if popu=0 then print " No default value available.": goto 67
    TPW=popu*5*7/2000
    wq=TPW: wqu=8
    print " DEFAULT ASSIGNED:  Waste quantity assigned a value"
    print " of ";: print using "###";wq;: print " TPW"
 71 print r6$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 65
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 71
 75 if s%=1 then s%=0: goto 225
    rem
    rem  ----Get Operating Schedule-----
    rem
 76 delay 2
    print chr$(12): input " Enter number of days/week for HRI opera-
tion: ",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)>0 and val(in$)<8 then ndays=val(in$): goto 80
    print r3$
    print " Expecting value between 1 and 7.": goto 75
 80 print: input " Enter number of shifts/day for HRI operation: ",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)>0 and val(in$)<4 then nshift=val(in$): goto 85
    print r3$
    print " Expecting a value between 1 and 3.": goto 80
 85 nhours=ndays*nshift*8
    rem  -----Issue Error Message if Hours Per Week is Less Than 40---
--
    if nhours>39 goto 90
    print " You will be operating your HRI for less than 40 hours per
week."
    print " This is excessively inefficient!"
 86 print " Choose an option: "
    print "     (1) Increase hours of operation to 40 hours per week."
    print "     (2) Abort program."
    print "     (3) Input new values."
    input " Type 1 or 2: ",yn$
    if ucase$(yn$)="QUIT" or yn$="2" goto 999
    if yn$="3" goto 75
    if yn$<>"1" then print r3$: goto 86
    nhours=40: ndays=5: nshift=3
    print " Assigning a value of 40 t  number of hours."
 90 if s%=1 then s%=0: goto 230
    rem
```

```
    rem  ---Get Landfill Life Expectancy---
    rem
 91 delay 2
    print chr$(12): input " Enter remaining landfill life in years:
",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)<0 then print r3$: goto 91
    llife=val(in$)
    ldate=tdate+llife
    if (eol-ldate)<1.0 goto 95
    print " Since landfill life is less than the project life, the
Capital Cost"
    print " of a Replacement Landfill for ";fix(eol-ldate);" years is
needed."
 92 input " Enter dollar value or ? for default: ",in$
    if ucase$(in$)="QUIT" goto 999
    if in$="?" goto 93
    if val(in$)<1 then print r3$: goto 92
    repcc=val(in$): goto 95
    rem   ---Default value of $15/ton provided by L. Hickman at GRCDA-
--
 93 repcc=15.0*TPW*52*(eol-ldate)*cinf
    print " Assigning a default value of ";: print us-
ing"$$$#######,.##";repcc
 94 print r6$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 90
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 94
    rem   ---Assign Salvage Value if Appropriate---
 95 if (ldate-eol)>1.0 then salv=15.0*TPW*52*(ldate-eol)*cinf else
salv=0.0
    if salv>0.0 then print " Assigning a salvage value of ";: print
using"$$$#######,.##";salv
 96 if s%=1 then s%=0: goto 235
    rem
    rem   ---Get Landfill Tipping Fee---
    rem
 97 delay 2
    print chr$(12): print " In which units do you wish to enter
landfill disposal costs?"
    print " This is usually tipping fee plus any transportation
costs."
    print s$
    print " $/ton          1"
    print " $/cuy          2"
    print " don't know     3"
    input " Type 1, 2, or 3: ",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)>0 and val(in$)<4 then lfcu=val(in$): goto 100
    print r3$
    print " Expecting a value between 1 and 3.": goto 97
100 gosub 996
    print: print " Enter the current landfill disposal costs in"
    print " terms of $";in$;: input " else type ? : ",in$
    if ucase$(in$)="QUIT" goto 999
    if in$="?" goto 110
    if val(in$)>0 then lfc=val(in$): goto 105
    print r3$: print " Expecting a positive number.": goto 100
105 gosub 996
```

```
    print " The value you have specified is ";: print using "$$$$#,.#-
#";lfc;:print in$
    print r2$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 95
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 105
    if refcost=0 goto 112
    rem  -----Check to See if Tipping Fee is Within Range-----
    if lfcu<>2 and lfc>(refcost*0.75/(TPW*52)) and lfc<(refcost*1.25/-
(TPW*52)) goto 112
    if wastype<2 and lfc>(refcost*0.75*9*27/(TPW*52*2000)) and lfc<(r-
efcost*1.25*9*27/(TPW*52*2000)) goto 112
    if fix(wastype)=2 and lfc>(refcost*0.75*17.5*27/(TPW*52*2000)) and
lfc<(refcost*1.25*17.5*27/(TPW*52*2000)) goto 112
    if wastype=3 and lfc>(refcost*0.75*32.4*27/(TPW*52*2000)) and
lfc<(refcost*1.25*32.5*27/(TPW*52*2000)) goto 112
106 print r5$;"the table value of ";
    print using "$$$#.##"; (refcost/(TPW*52));
    print "/ton"
    print r4$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then lfcflg$="*": goto 112
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 106
    rem  -----Set Default Value for Tipping Fee-----
110 if refcost=0 then print " No default value available.": goto 100
    lfc=refcost/(TPW*52): lfcu=1
    print " Assigning a value of ";: print using "$$$#.##";lfc;: print
"/ton"
111 print r6$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 95
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 111
    rem
    rem  ---Get Ash Disposal Cost---
    rem
112 print: print " If different from the cost of waste disposal,"
    print " the ash disposal cost is needed."
    print " Any non-numeric entry will set the two costs equal."
    input " Enter the ash disposal cost in $/ton if different:",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)>0 then
     ashc=val(in$)
    else
     ashc=lfc
     if wastyp<2 and lfcu=2 then ashc=ashc*2000/(9*27)
     if fix(wastyp)=2 and lfcu=2 then ashc=ashc*2000/(17.5*27)
     if wastyp=3 and lfcu=2 then ashc=ashc*2000/(32.5*27)
    end if
113 print " The value you have specified is ";: print using "$$$$#,.#-
#";ashc;: print "/ton."
    print r2$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 112
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 113
115 if s%=1 then s%=0: goto 240
    rem
    rem  ---Get Displaced Fuel---
    rem
109 delay 2
```

```
    print chr$(12): print " Please select fossil fuel to be dis-
placed:"
    print s$
    print " electricity                1"
    print " distillate oil             2"
    print " residual oil               3"
    print " natural gas                4"
    print " liquid propane gas         5"
    print " don't know                 6"
    input " Type 1, 2, 3, 4, 5, or 6: ",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)>0 and val(in$)<7 goto 116
    print r3$
    print " Expecting a number between 1 and 6.": goto 109
116 dftyp=val(in$)
    if dftyp=6 then dftyp=4
114 i=dftyp
    rem  -----Go To Subroutine to set Flags for Fuel Selected-----
    gosub 991
    dfunit=m
    if yn$="?" goto 118
    dfcst=j
    if dfcst>(0.75*table) and dfcst<(1.25*table) goto 120
117 print r5$;"the table value of ";: print using "$$#.##";table;:
print "/";in$
    print r4$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then dflg$="*": goto 120
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 117
118 if yn$="?" then gosub 995
    dfcst=table
    print " Assigning a value of ";: print using "$$#.##";dfcst;:
print "/";in$
119 print r6$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 114
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 119
    If dftyp=1 or dftyp=4 or dftyp=5 then dflg$="#"
120 if s%=1 then s%=0: goto 245
    rem
    rem  ---Get Auxiliary Fuel---
    rem
127 delay 2
    print chr$(12): print " Please select auxiliary fuel to be used:"
    print s$
    print " distillate oil             1"
    print " natural gas                2"
    print " liquid propane gas         3"
    print " don't know                 4"
    input " Type 1, 2, 3, or 4: ",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)>0 and val(in$)<5 goto 121
    print r3$
    print " Expecting a number between 1 and 4.": goto 127
121 aftyp=val(in$)
    if aftyp=1 then aftyp=2: goto 124
    if aftyp=2 then aftyp=4: goto 124
    if aftyp=3 then aftyp=5: goto 124
124 i=aftyp
    rem  -----Go To Subroutine to set Flags for Fuel Selected-----
```

```
    gosub 991
    afunit=m
    if yn$="?" goto 123
    afcst=j
    if afcst>(0.75*table) and afcst<(1.25*table) goto 125
122 print r5$;"the table value of ";: print using "$$#.##";table;:
print "/";in$
    print r4$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then aflg$="*": goto 125
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 122
123 if yn$="?" then gosub 995
    afcst=table
    print " Assigning a value of ";: print using "$$#.##";afcst;:
print "/";in$
126 print r6$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 124
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 126
    If aftyp=4 or aftyp=5 then aflg$="#"
125 if s%=1 then s%=0: goto 250
    rem
    rem  -----Get Price of Electricity-----
    rem
132 delay 2
    s%=0
    print chr$(12): print " Enter price of ELECTRICITY in cents/KWh"
    input " or ? for default value: ",in$
    if ucase$(in$)="QUIT" goto 999
    if in$="?" goto 135
    if val(in$)>0 goto 130
    print " Value must be greater or equal to 1.0."
    print " Please try again.": goto 125
130 print " You entered electricity as ";in$;chr$(155);"/KWh"
    print r2$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" then print " Re-enter cost.": goto 125
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 130
    eprice=val(in$)
    rem  -----Get Table Value for Cost of Electricity-----
    gosub 990
    if eprice>(0.75*table) and eprice<(1.25*table) goto 140
131 print r5$;"the value of ";: print using "##.##";table;: print
chr$(155);"/KWh."
    print r4$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then eflg$="*": goto 140
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 131
    goto 136
    rem  -----Set Default Value for Cost of Electricity-----
135 gosub 990
136 eprice=table
    print " Assigning a price of ";: print using "##.##";eprice;:
print chr$(155);"/KWh"
137 print r6$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 125
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 137
    eflg$="#"
    rem
```

```
    rem   ---Print Summary of Inputs---
    rem
140 open "O",#1,f1$
    rem  -----Go To Special Subroutine to Print Cent Sign if an Epson
is Used-----
    if pf$="Y" goto 600
141 print #1, chr$(27)"6"              'Set Up to Print Cent Sign
    print #1, chr$(10)
    print #1, tab(4);"Session Number: ";rn%
    print #1, tab(4);s$
    print #1, tab(4);"|";tab(31);"SUMMARY OF INPUTS";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);"|";" INSTALLATION NAME: ";tab(44);post$;tab(75)-
;"|"
    print #1, tab(4);"|";" REGION: ";tab(44);region;tab(75);"|"
    print #1, tab(4);"|";" PROJECT FISCAL YEAR: "tab(44);FY$;tab(75)-
;"|"
    print #1, tab(4);"|";" WASTE TYPE: ";tab(44);wastype;tab(75);"|"
    print #1, tab(4);"|";hcflg$;"HEAT CONTENT: ";tab(44);heatcnt;tab(-
75);"|"
    gosub 997
    print #1, tab(4);"|";wqflg$;"WASTE QUANTITY: ";tab(39);: print #1,
using "#######,.";wq;: print #1, " ";in$;tab(75);"|"
    print #1, tab(4);"|";" DAYS/WEEK: ";tab(44);ndays;tab(75);"|"
    print #1, tab(4);"|";" SHIFTS/DAY: ";tab(44);nshift;tab(75);"|"
    print #1, tab(4);"|";" LANDFILL LIFE: ";tab(44);llife;"
years";tab(75);"|"
    if repcc=0 goto 142
    print #1, tab(4);"|";" LANDFILL REPLACEMENT COST: ";tab(44);:
print #1, using "$$$$#######,.";repcc;: print #1, tab(75);"|"
142 if salv=0 goto 143
    print #1, tab(4);"|";" LANDFILL SALVAGE VALUE: ";tab(44);: print
#1, using "$$$$#######,.";salv;: print #1, tab(75);"|"
143 gosub 996
    print #1, tab(4);"|";lfcflg$;"LANDFILL COSTS: ";tab(44);: print
#1, using"$$$$#,.##";lfc;: print #1, in$;tab(75);"|"
    print #1, tab(4);"|";" ASH DISPOSAL COST: ";tab(44);: print #1,
using"$$$$#,.##";ashc;: print #1, "/ton";tab(75);"|"
    print #1, tab(4);"|";" FUEL TYPE: ";tab(44);f$(dftyp);tab(75);"|"
    print #1, tab(4);"|";dflg$;"FUEL COSTS: ";tab(44);: print #1,
using"$$#.##";dfcst;
    if dfunit=2 then print #1,"/";fcun$(dftyp);tab(75);"|" else print
#1, "/MBtu";tab(75);"|"
    print #1, tab(4);"|";" AUXILIARY FUEL TYPE: ";tab(44);f$(aftyp);t-
ab(75);"|"
    print #1, tab(4);"|";aflg$;"AUXILIARY FUEL COSTS: ";tab(44);:
print #1, using"$$#.##";afcst;
    if afunit=2 then print #1,"/";fcun$(aftyp);tab(75);"|" else print
#1, "/MBtu";tab(75);"|"
    print #1, tab(4);"|";eflg$;"ELECTRICITY COSTS: ";tab(44);: print
#1, using "##.#";eprice;
    print #1, tab(50);chr$(155);"/KWh";tab(75);"|"
    print #1, tab(4);s$
    if dflg$="#" or aflg$="#" or eflg$="#" then print #1, tab(4);" #
Default value for gas or electricity which must be verified."
    print #1, tab(4);" * ";r5$;"the table value."
    s2$="** NOTE: MBtu means MILLIONS of Btu's."
    print #1, tab(4);s2$
    print #1,: print #1,
    rem  -----Convert Cost of Electricity to $/MBtu-----
```

```
    bepr=eprice*kwmbt
    rem  -----Determine if Effective Size of Plant is within Valid
Range-----
    TPD=TPW*3/(ndays*nshift)
    if TPD>9.0 and TPD<201.0 goto 145
    print " Your effective plant size is ";: print using "##.#";TPD;:
print " TPD"
    print " This is the burning capacity needed for the amount of
waste avaialble"
    print " and the operational hours specified."
    print " This value is outside the valid range of this program."
    print " Please seek SPECIAL TECHNICAL ASSISTANCE!"
    close #1
    delay 3: goto 999
    rem
    rem  -----Calculate Size of Incinerator Units-----
    rem
145 temp1=int(TPD/5.1)
    temp2=int(TPD/10.1)
    temp3=int(TPD/15.1)
    size1=(temp1+1)*5
    size2=(temp2+1)*5
    size3=(temp3+1)*5
    rem
    rem   ---Find the smallest acceptable plant size---
    rem
    if (size1*2)>(size2*3) then FS=size2: NI=3: goto 146
    FS=size1: NI=2
146 if (size3*4)<(FS*NI) then FS=size3: NI=4
    totcap=FS*NI
    rem
    rem  -----Capital Construction Cost based on Argonne Report-----
    rem
148 CC=(1000.0*100*totcap^-0.2)*cinf
    APCC=(78470.51*totcap^-0.56432)*cinf
    hricc=totcap*(CC+APCC)
    rem
    rem   ---O&M Cost from Argonne Report---
    rem
    OMcst=(25.0+(33.504*(FS*(NI-1))^-0.6085))*ominf
    hriom=TPW*52*OMcst
    rem
    rem   ---Make sure landfill costs are in $/ton---
    rem
    if lfcu=1 or lfcu=3 goto 150
    if wastyp<2 then lfc=lfc*2000/(9*27)
    if fix(wastyp)=2 then lfc=lfc*2000/(17.5*27)
    if wastyp=3 then lfc=lfc*2000/(32.5*27)
    rem  -----Calculate Landfill Cost Savings-----
150 ls=52*TPW*(lfc-ashc*0.4-ashc*0.121)
    rem
    rem  -----Auxiliary Fuel Requirements-----
    rem
    mbton=0.0001261*(nhours*nhours)-0.03893*nhours+3.23
    AFQ=mbton*52*TPW
    if afunit=2 then bafc=afcst/fcnv(aftyp) else bafc=afcst
    afc=AFQ*bafc
    rem
    rem  -----Determine Thermal Output-----
    rem
```

```
    HP=0.5*(52*TPW*heatcnt*2000/1000000+AFQ)
    if dfunit=2 then bdfc=dfcst/fcnv(dftyp) else bdfc=dfcst
    GFS=HP*bdfc/erf(dftyp)
    YASP=HP*1000:                          Rem  ---Yearly steam produc-
tion---
    DASP=(YASP/52)/ndays:                  Rem  ---Daily steam produc-
tion---
    if nshift=3 then stmhr=24 else stmhr=nshift*8~2.0
    HASP=DASP/stmhr:                       Rem  ---Hourly steam produc-
tion---
    rem
    rem   ---Compute Auxiliary Fuel Quantity Requirements---
    rem
    YAFR=AFQ/fcnv(aftyp):                  Rem  ---Yearly Aux. Fuel
consumption---
    DAFR=YAFR/(52*ndays):                  Rem  ---Daily Aux. Fuel
consumption---
    HAFR=DAFR/(nshift*8):                  Rem  ---Hourly Aux. Fuel
consumption---
    rem
    rem   ---Compute Displaced Fuel Quantity---
    rem
    YDF=HP/erf(dftyp):                     Rem  ---Yearly heat displaced-
--
    YDFU=YDF/fcnv(dftyp):                  Rem  ---Yearly displaced fuel-
--
    DDFU=YDFU/(52*ndays):                  Rem  ---Daily displaced fuel--
-
    HDFU=DDFU/(nshift*8):                  Rem  ---Hourly displaced fuel-
--
    rem
    rem   ---Compute Operational Hours---
    rem
    DIO=nshift*8:                          Rem  ---Daily hours---
    YIO=nhours*52:                         Rem  ---Yearly hours---
    rem
    rem   ---Refuse Disposal---
    YRD=TPW*52
    DRD=(TPW/ndays)*(nshift/3)
    if wastype<2 then TRD=YRD*2000/(27*9)
    if fix(wastype)=2 then TRD=YRD*2000/(27*17.5)
    if wastype=3 then TRD=YRD*2000/(27*32.5)
    rem
    rem   ---Compute Yearly Electrical---
    rem
    YELQ=(0.1297+(0.5728*(FS*(NI-1))^-0.4682))*52.0*TPW
    YELC=YELQ*bepr
    rem
    rem   ---Compute Net Energy Savings---
    rem
    NFS=GFS-AFC-YELC
    rem
    rem   ------------------END COMPUTATIONS-------------
    rem
    rem   -----Print Outputs-----
    rem
    print #1, tab(4);s$
    print #1, tab(4);"|";tab(31);"SUMMARY OF OUTPUTS";tab(75);"|"
    print #1, tab(4);s$
```

```
    print #1, tab(4);"|";"TONS PER 7 DAY WEEK OF WASTE: ";tab(60);:
print #1, using "####";TPW;: print #1, " tons/week";tab(75);"|"
    print #1, tab(4);"|";"INDIVIDUAL INCINERATOR CAPACITY: ";tab(60);-
FS;" tons";tab(75);"|"
    print #1, tab(4);"|";"NUMBER OF INCINERATORS REQUIRED: ";tab(60);-
NI;tab(75);"|"
    print #1, tab(4);"|";"TOTAL FACILITY CAPACITY: ";tab(60);totcap;"
tons/day";tab(75);"|"
    print #1, tab(4);"|";"CAPITAL COSTS: ";tab(60);: print #1, us-
ing"$$####,.";CC;: print #1, "/ton";tab(75);"|"
    print #1, tab(4);"|";"APC CAPITAL COST: ";tab(60);: print #1,
using"$$####,.";APCC;: print #1, "/ton";tab(75);"|"
    print #1, tab(4);"|";"HRI CONSTRUCTION COSTS: ";tab(60);: print
#1, using"$$$######,.";hricc;: print #1, tab(75);"|"
    print #1, tab(4);"|";"O&M COSTS: ";tab(60);: print #1, us-
ing"$$#."; OMcst;: print #1, "/ton";tab(75);"|"
    print #1, tab(4);"|";"HRI O&M COSTS: ";tab(57);: print #1, us-
ing"$$$$######,.";hriom;: print #1, "/year";tab(75);"|"
    print #1, tab(4);"|";"LANDFILL SAVINGS: ";tab(57);: print #1,
using"$$$$######,.";ls;: print #1, "/year";tab(75);"|"
    print #1, tab(4);"|";"HEAT PRODUCTION: ";tab(57);: print #1,
using"#######,.";HP;: print #1, " MBtu/yr";tab(75);"|"
    print #1, tab(4);"|";"FUEL COSTS: ";tab(60);: print #1, us-
ing"$#.##";bdfc;: print #1, "/MBtu";tab(75);"|"
    print #1, tab(4);"|";"AUXILIARY FUEL COST: ";tab(60);: print #1,
using"$#.##";bafc;: print #1, "/MBtu";tab(75);"|"
    print #1, tab(4);"|";"ELECTRICITY COST: ";tab(60);: print #1,
using"$$#.##";bepr;: print #1, "/MBtu";tab(75);"|"
    print #1, tab(4);"|";"ENERGY RECOVERY FACTOR: ";tab(60);: print
#1, using"##.#";(erf(dftyp)*100);: print #1, "%";tab(75);"|"
    print #1, tab(4);"|";"NUMBER OF HOURS OPERATIONAL: ";tab(60);:
print #1, using"####";nhours;: print #1, " hours/week";tab(75);"|"
    print #1, tab(4);"|";"NUMBER OF MBtu OF FUEL NEEDED PER TON OF
.WASTE BURNED: ";tab(60);: print #1, using"#.###";mbton;: print #1, "
MBtu/ton";tab(75);"|"
    print #1, tab(4);"|";"GROSS FUEL SAVINGS: ";tab(57);: print #1,
using"$$$#######,.##";GFS;: print #1, "/yr";tab(75);"|"
    print #1, tab(4);"|";"YEARLY AUXILIARY FUEL COSTS: ";tab(60);:
print #1, using"$$$###,.##";afc;: print #1, "/yr";tab(75);"|"
    print #1, tab(4);"|";"YEARLY AUXILIARY FUEL QUANTITY: ";tab(60);:
print #1, using"#####,.";AFQ;: print #1, " MBtu/yr";tab(75);"|"
    print #1, tab(4);"|";"YEARLY ELECTRICITY COSTS: ";tab(60);: print
#1, using"$$$#####,.##";YELC;: print #1, "/yr";tab(75);"|"
    print #1, tab(4);"|";"YEARLY ELECTRICITY QUANTITY: ";tab(60);:
print #1, using"#####,.";YELQ;: print #1, " MBtu/yr";tab(75);"|"
    print #1, tab(4);"|";"NET FUEL SAVINGS: ";tab(57);: print #1,
using"$$$$######,.";NFS;: print #1, "/yr";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);s2$
    rem
    rem  ---PRINT SUMMARY REPORTS---
    rem
    print #1, chr$(12)
    print #1, tab(68);"Page 2"
    print #1, tab(4);s$
    print #1, tab(4);"|";tab(30);"STEAM SUPPLY SUMMARY";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);"|";"Total Amount  f Steam Produced: ";tab(45);:
print #1, using"########,.";HP;: print #1, " MBtu/year";tab(75);"|"
    print #1, tab(4);"|";tab(75);"|"
```

```
    print #1, tab(4);"|";"Yearly Amount of Steam Produced: ";tab(45);:
print #1, using"###########,.";YASP;: print #1, " lb/year";tab(75);"|"
    print #1, tab(4);"|";"Daily Amount of Steam Produced: ";tab(45);:
print #1, using"#######,.";DASP;: print #1," lb/day";tab(75);"|"
    print #1, tab(4);"|";"Hourly Amount of Steam Produced: ";tab(45);:
print #1, using"#####,.";HASP;: print #1, " lb/hour";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);"|";tab(27);"AUXILIARY FUEL REQUIRE-
MENTS";tab(75);"|"
    print #1, tab(4);S$
    print #1, tab(4);"|";"Auxiliary Fuel Type: ";tab(45);f$(aftyp);ta-
b(75);"|"
    print #1, tab(4);"|";tab(75);"|"
    print #1, tab(4);"|";"Fuel Requirements: ";tab(45);: print #1,
using"#####,.";AFQ;: print #1, " MBtu/year";tab(75);"|"
    print #1, tab(4);"|";tab(75);"|"
    print #1, tab(4);"|";"Yearly: ";tab(45);: print #1, us-
ing"#####,.";YAFR;: print #1, " ";fcun$(aftyp);"/year";tab(75);"|"
    print #1, tab(4);"|";"Daily: ";tab(45);: print #1, us-
ing"###.##";DAFR;: print #1, " ";fcun$(aftyp);"/day";tab(75);"|"
    print #1, tab(4);"|";"Hourly: ";tab(45);: print #1, us-
ing"##.##";HAFR;: print #1, " ";fcun$(aftyp);"/hour";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);"|";tab(27);"OPERATING SCHEDULE SUMMA-
RY";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);"|";"Incinerator Operation: ";tab(45);ndays;"day-
s/week";tab(75);"|"
    print #1, tab(4);"|";tab(45);nshift;"shifts/day";tab(75);"|"
    print #1, tab(4);"|";tab(75);"|"
    print #1, tab(4);"|";"Daily Operation:
";tab(45);DIO;"hours/day";tab(75);"|"
    print #1, tab(4);"|"  Weekly Operation: ";tab(45);nhours;"hours/w-
eek";tab(75);"|"
    print #1, tab(4);"|";"Yearly Operation: ";tab(45);YIO;"hours/year-
";tab(75);"|"
    print #1, tab(4);"|";tab(75);"|"
    print #1, tab(4);"|";"Effective Steaming Time: ";tab(45);stmhr;"h-
ours/day";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);"|";tab(29);"REFUSE DISPOSAL SUMMARY";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);"|";"Total Weight Disposed: ";tab(45);: print #1,
using"######,.";YRD;: print #1, " tons/year";tab(75);"|"
    print #1, tab(4);"|";tab(45);: print #1, using"#####,.";TPW;:
print #1, " tons/week";tab(75);"|"
    print #1, tab(4);"|";tab(45);: print #1, using"#####,.";DRD;:
print #1, " tons/day";tab(75);"|"
    print #1, tab(4);"|";tab(75);"|"
    print #1, tab(4);"|";"Total Volume Disposed: ";tab(45);: print #1,
using"#######,.";TRD;: print #1, " cuy/year";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);"|";tab(29);"DISPLACED FUEL SUMMARY";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);"|";"Displaced Fuel Type: ";tab(45);f$(dftyp);ta-
b(75);"|"
    print #1, tab(4);"|";tab(75);"|"
    print #1, tab(4);"|";"Amount Displaced: ";tab(45);: print #1,
using"########,.";YDF;: print #1, " MBtu/year";tab(75);"|"
    print #1, tab(4);"|";tab(75);"|"
```

```
    print #1, tab(4);"|";tab(45);: print #1, using"#########,.";YDFU;:
print #1, " ";fcun$(dftyp);"/year";tab(75);"|"
    print #1, tab(4);"|";tab(45);: print #1, using"#####,.";DDFU;:
print #1, " ";fcun$(dftyp);"/day";tab(75);"|"
    print #1, tab(4);"|";tab(45);: print #1, using"###,.##";HDFU;:
print #1, " ";fcun$(dftyp);"/hour";tab(75);"|"
    print #1, tab(4);s$
    print #1, tab(4);s2$
    print #1, chr$(27)"@"              'Reset Code to Cancel Cent Sign
    close #1
    rem
    rem  ---END OF REPORTS---
    rem
    delay 2
    print chr$(12): print " CAUTION: about to enter Life Cycle Cost in
Design (LCCID) segment."
155 input " Do you wish to proceed with this analysis (Y/N)?:",f2$
    if ucase$(f2$)="QUIT" goto 999
    if left$(ucase$(f2$),1)="N" goto 189
    if left$(ucase$(f2$),1)<>"Y" then print r1$: goto 155
    delay 2
    on error goto 989                                          'Set
Error Trap for Existing File Name
    open "I",#2,(stdy$+".lc")
    close #2
    rem  -----Give Options for LCC File That Already Exists-----
165 print " The study file, ";stdy$;" from a previous session already
exists ..."
    print " Options:"
    print "  (1) Give a new name to your study."
    print "  (2) Quit LCCID analysis and return to HRI."
    print "  (3) Use filename that already exists, BUT existing file"
    print "  will be OVERWRITTEN and the contents will be destroyed."
    input " Type 1, 2, or 3:",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)<1 or val(in$)>3 then print r3$: print " Expecting a
value of 1 to 3.": goto 165
    if val(in$)=2 goto 999
    if val(in$)=3 goto 170
    delay 2: print chr$(12)
    rem  ---Use Operating System Call to List Existing Files-----
    print " List of existing files .... do not use when naming your
file."
    shell "dir *.lc/w"
    locate 23,1
    print " PLEASE NOTE the extension is automatically appended to all
file names."
161 input " Enter a different study name.:",stdy$
162 if ucase$(stdy$)="QUIT" goto 999
    if len(stdy$)>5 then print r3$: goto 161
    if ucase$(stdy$)="HRI" then print " HRI by itself is not an
allowable name.": goto 161
    goto 175
    rem  -----Option to Delete Existing File with Given Name-----
170 print " Are you sure you want to overwrite the file ";stdy$;:
input " (Y/N)?: ",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 1
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 170
    sh$="del "+stdy$+".lc":  shell sh$
```

```
    sh$="del "+stdy$+".rpt": shell sh$
175 on error goto 0:                              rem -----turn off error
trap-----
    rem
    rem  -----Begin Printing File to Provide Input to LCCID-----
    rem
    open "O",#1,"lcc_in.   "
    print #1, "n"
    print #1, stdy$
    print #1, "y"                                  ' new study
    print #1,                                      ' cr
    print #1, "s"                                  ' main menu
    print #1, "1"                                  ' project type
    print #1, "y"                                  ' Sign. of energy
    print #1, "y"                                  ' Prim study obj.
    print #1, "2"
    print #1, "m"                                  ' $ input mult.
    print #1, "1"                                  ' input mult.
    print #1, "e"                                  ' study param.
    print #1, "s"                                  ' ERSI menu
    print #1, state$                               ' state
    print #1, "y"                                  ' state correct
    print #1,                                      ' energy escalate
    print #1, "k"                                  ' ERSI menu
    print #1, "2"                                  ' energy units
    print #1, "p"                                  ' ERSI menu
    print #1, "1"                                  ' E price menu
    print #1, using "###.##";bepr                  ' price
    print #1, dftyp                                ' displaced fuel
menu
    print #1, using "###.##";bdfc                  ' price
    print #1, aftyp                                ' aux. fuel menu
    print #1, using "###.##";bafc                  ' price
    print #1,                                      ' exit prices
    print #1,                                      ' exit ERSI menu
    print #1, "t"                                  ' study param.
    input " Enter the Project Number: ",in$
    if ucase$(in$)="QUIT" goto 999
    print #1, in$
    print #1, FY$                                  ' fiscal year
    print #1, " Heat Recovery Incinerator"          ' proj. title
    print #1, post$                                ' instal. name
    input " Enter name of person doing study: ",in$
    if ucase$(in$)="QUIT" goto 999
    print #1, in$                                  ' name
    print #1, "Alternative Evaluation"             ' design feature
    print #1,                                      ' ID block menu
    print #1, "d"                                  ' study param.
    print #1, dte$                                 ' date of study
    print #1, M$                                   ' midpoint date
    print #1, BOD$                                 ' occupancy date
    print #1, "15"                                 ' econ. life
    print #1, "y"                                  ' calc yr/mnth
    print #1,                                      ' exit project dates
    print #1,                                      ' stdy param.
    print #1, "a"                                  ' select alterna-
tives
    print #1, "s"                                  ' def/ch alt.
    print #1, "a"                                  ' alt. ID
    print #1, "Landfill"                           ' alt. title
```

```
    print #1, "m"                                   ' maintenance cost
    print #1, "s"                                   ' define cost
    print #1, "0"                                   ' new cost
    print #1, "O&M"                                 ' title
    print #1, using "####.##";(ls/1000)             ' landfill
cost/savings
    print #1,                                       ' exit menu
    print #1, "v"                                   ' select capital
cost
    print #1, using "#####.##";(repcc/1000)         ' landfill replace-
ment cost
    if repcc=0 or ldate<(val(FY$)+2) then
      print #1,
    else
    ldate=ldate+1900-1
    print #1, ("03/"+right$(str$(cint(ldate)),4)) ' enter date and
exit
    end if
    if salv>0.0 then print #1, "s": print #1, using"##########.##";(-
salv/1000): print #1,
    print #1, "e"                                   ' select energy
usage
    print #1, "0"                                   ' electrical usage
    print #1, "y"                                   ' correct
    print #1, "0"                                   ' accommodate LCCID
input requirements
    print #1, "y"                                   '
    print #1, "0"                                   '
    print #1, "y"                                   '
    print #1, dftyp                                 ' identify displaced
fuel
    print #1, using "######";YDF                   ' amount of fuel
    print #1, "y"                                   ' correct
    print #1,                                       ' exit menu
    print #1,                                       ' exit menu
    print #1, "s"                                   ' define new alt.
    print #1, "b"                                   ' alt. ID
    print #1, "HRI"                                 ' alt. title
    print #1,
    print #1, "v"                                   ' choose capital
cost
    print #1, using "#####.#";(hricc/1000)          ' hri construction
cost
    print #1,                                       ' correct date
    print #1, "e"                                   ' select energy menu
    print #1, using "#####.#";YELQ                  ' electrical energy
    print #1, "y"                                   ' correct
    print #1, "0"                                   ' accommodate LCCID
input requirements
    print #1, "y"                                   '
    print #1, "0"                                   '
    print #1, "y"                                   '
    print #1, "0"                                   ' no demand charge
    print #1, "y"                                   '
    print #1, aftyp                                 ' type of aux. fuel
    print #1, using "#####.#";AFQ                   ' amount of aux.
fuel
    print #1, "y"                                   ' correct
    print #1,                                       ' alt. main menu
    print #1, "m"                                   ' maint. menu
```

```
    print #1, "s"                                   ' define
    print #1, "0"                                   ' new
    print #1, "O&M"                                 ' title
    print #1, using "####.#";(hriom/1000)           ' value in thousands
    print #1,                                       ' exit menu
    print #1,                                       ' exit menu
    print #1,                                       ' exit menu
    print #1, "c"                                   ' calculate LCC
    print #1, "b"                                   ' select baseline
    print #1, "a"                                   ' landfill
    print #1, "c"                                   ' comparative report
    print #1, "n"                                   ' don't print to
screen
    print #1, "n"                                   ' don't print
directly to printer
    print #1, "y"                                   ' print report to a
file
    print #1,                                       ' same name accept-
able
    print #1, "y"                                   ' compare with
selected baseline
    print #1, "y"                                   ' display DPP values
    print #1, "n"                                   ' don't print
detailed SIR & DPP
    print #1,
    print #1,
    close #1
189 delay 2
    rem  -----Final Instructions-----
    print chr$(12): print " Finished ..."
    print " The results of this session have been"
    print " saved in a file called ";f1$
    print
190 input " Do you want the results printed to the screen (Y/N)?:
",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 195
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 190
    rem  -----Operating System Shell Command to Print File to Screen--
---
    sh$="type "+f1$+"|more"
    shell sh$
    locate 24,1
195 if left$(ucase$(f2$),1)="Y" goto 999
    input " Do you want a new session (Y/N)?: ",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" goto 9 9
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 195
    if (rn%+1)>99 then print " Limited to 99 sessions.  Terminating.":
goto 999
    rem
    rem  ----Ask What Values to Change-----
    rem
    rn%=rn%+1
    i=len(str$(rn%))-1
    f1$=stdy$+".0"+right$(str$(rn%),i)
205 print chr$(12): input " Do you desire a new study name (Y/N)?:"-
,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 5
```

```
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 205
    on error goto 998
    s%=2
    open "I",#1,f1$
    close #1
    s%=1
    goto 8
200 print chr$(12): input " Do you desire to change the Fiscal Year
for the study (Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 12
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 200
210 print chr$(12): input " Do you desire to change the installation
(Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 15
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 210
215 print chr$(12): input " Do you desire to change the type of waste
(Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 50
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 215
220 print chr$(12): input " Do you desire to change the quantity of
waste (Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 66
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 220
    if left$(ucase$(yn$),1)="N" then s%=2: goto 72
225 print chr$(12): input " Do you desire to change the plant operat-
ing schedule (Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 76
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 225
230 print chr$(12): input " Do you desire to change the Landfill Life
Expectancy/Cost (Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 91
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 230
235 print chr$(12): input " Do you desire to change the Landfill
Tipping fee (Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 97
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 235
240 print chr$(12): input " Do you desire to change the Displaced fuel
(Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 109
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 240
245 print chr$(12): input " Do you desire to change the Auxiliary fuel
(Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 127
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 245
250 print chr$(12): input " Do you desire to change the cost of
Electricity (Y/N)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" then s%=1: goto 132
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 250
    goto 140
    rem
```

```
    rem  ----Start by Using Previous File-----
    rem
500 print chr$(12): input " Enter Complete name of file including
extension.: ",f1$
    open "I",#1,f1$
    input# 1,in$
    input# 1,in$
    input# 1,in$
    rn%=val(mid$(in$,16,5))
    for p=1 to 4
    input# 1,in$
    next p
    rem ---Get Post Name---
    in$=mid$(in$,41,30)
    y=instr(in$,"  ")
    in$=left$(in$,(y-1))
    open "I",#2,"names.i"
505 if eof(2) goto 510
    input# 2,post$,state$,macom$,region,popu,refcost
    if instr(post$,in$)>0 goto 515
    goto 505
510 print " ERROR: Invalid installation name in file!": goto 599
515 close #2
    input# 1,in$
    rem ---Get Fiscal Year---
    input# 1,in$
    FY$=mid$(in$,41,2)
    rem ---Get Waste Type---
    input# 1,in$
    in$=mid$(in$,42,1)
    wastype=val(in$)
    rem ---Get Heat Content---
    input# 1,in$
    if mid$(in$,2,1)="*" then hcflg$="*": print " Check Value for
Waste Heat Content."
    in$=mid$(in$,41,5)
    heatcnt=val(in$)
    rem ---Get Waste Quantity and Units---
    input# 1,in$
    if mid$(in$,2,1)="*" then wqflg$="*": print " Check Value for
Waste Quantity."
    wq=val(mid$(in$,38,7))
    in$=mid$(in$,46,13)
    if in$="tpd (5day)    " then wqu=1
    if in$="tpd (7 day)   " then wqu=2
    if in$="tpy           " then wqu=3
    if in$="cuy/d (5 day)" then wqu=4
    if in$="cuy/d (7 day)" then wqu=5
    if in$="cuy/yr        " then wqu=6
    if in$="TPW           " then wqu=8
    rem ---Get Operating Schedule---
    input# 1,in$
    ndays=val(mid$(in$,42,1))
    input# 1,in$
    nshift=val(mid$(in$,42,1))
    nhours=ndays*nshift*8
    rem ---Get Landfill Life---
    input# 1,in$
    llife=val(mid$(in$,42,3))
    rem ---Get Landfill Replacement/Salvage Values if Present---
```

```
    input# 1,in$
    if mid$(in$,12,16)="REPLACEMENT COST" or mid$(in$,12,13)="SALVAGE
VALUE" then input# 1,i2$,i3$: in$=in$+i2$+i3$
    repcc=0: salv=0
    y=instr(in$,"$")
    if mid$(in$,12,16)<>"REPLACEMENT COST" goto 520
    repcc=val(mid$(in$,(y+1),7))
520 if mid$(in$,12,13)<>"SALVAGE VALUE" goto 525
    salv=val(mid$(in$,(y+1),7))
    rem ---Get Landfill/Ash Cost---
525 if repcc<>0 or salv<>0 then input# 1,in$
    if mid$(in$,2,1)="*" then lfcflg$="*": print " Check Value for
Landfill Tip Cost."
    y=instr(in$,"$")
    lfc=val(mid$(in$,(y+1),6))
    p=instr(in$,"/")
    if mid$(in$,p,4)="/ton" then lfcu=1
    if mid$(in$,p,4)="/cuy" then lfcu=2
    input# 1,in$
    y=instr(in$,"$")
    ashc=val(mid$(in$,(y+1),6))
    rem ---Get Displaced Fuel, Costs, and Units---
    input# 1,in$
    in$=mid$(in$,41,18)
    if in$="electricity       " then dftyp=1
    if in$="distillate oil    " then dftyp=2
    if in$="residual oil      " then dftyp=3
    if in$="natural gas       " then dftyp=4
    if in$="liquid propane gas" then dftyp=5
    input# 1,in$: y=instr(in$,"$")
    if mid$(in$,2,1)="*" then dflg$="*": print " Check Value for
Displaced Fuel Cost."
    if mid$(in$,2,1)="#" then dflg$="#": print " Update Default Value
for Displaced Fuel Cost."
    dfcst=val(mid$(in$,(y+1),5))
    y=instr(in$,"/")
    in$=mid$(in$,y,8)
    if in$="/MBtu   " then dfunit=1 else dfunit=2
    rem ---Get Auxiliary Fuel, Costs, and Units---
    input# 1,in$
    in$=mid$(in$,41,18)
    if in$="distillate oil    " then aftyp=2
    if in$="natural gas       " then aftyp=4
    if in$="liquid propane gas" then aftyp=5
    input# 1,in$: y=instr(in$,"$")
    if mid$(in$,2,1)="*" then aflg$="*": print " Check Value for
Auxiliary Fuel Cost."
    if mid$(in$,2,1)="#" then aflg$="#": print " Update Default Value
for Auxiliary Fuel Cost."
    afcst=val(mid$(in$,(y+1),5))
    y=instr(in$,"/")
    in$=mid$(in$,y,8)
    if in$="/MBtu   " then afunit=1 else afunit=2
    rem ---Get Electicity Costs---
    input# 1,in$
    if mid$(in$,2,1)="*" then eflg$="*": print " Check Value for
Electricity Cost."
    if mid$(in$,2,1)="#" then eflg$="#"  print " Update Default Value
for Electricity Cost."
    eprice=val(mid$(in$,41,4))
```

```
    close #1
    delay 3
    print: s%=2
    rn%=rn%+1: goto 5
530 print: print " You will now be given a chance to change the input
values."
    print " Press any key when ready to continue."
    in$=input$(1): goto 200
599 close #1: print chr$(12): goto 4
    rem
    rem  ---SUBROUTINES---
    rem
    rem  -----Subroutine to Set Up Code to Print Cent Sign on Epson
Printers-----
    rem
600 print #1, chr$(27)":"chr$(0)chr$(0)chr$(0); 'copy ROM character
set to RAM
    print #1, chr$(27)"%"chr$(1)chr$(0);  'activate RAM area of
printer memory
    print #1, chr$(27)"&"chr$(0)chr$(155)chr$(155);  'send codes to
ram for the characters specified
    print #1, chr$(139);                'set character attributes
    restore
    for x=1 to 11: read c: print #1, chr$(c);: next x  'read the pin
codes and store
    goto 141
1170 data 24,36,0,231,0,36,0,0,0,0,0
    rem
    rem  -----Subroutine to Help With Names of States-----
    rem
775 print " AK = Alaska   AL = Alabama   AR = Arkansas   AZ = Arizona"
    print " CA = Califc nia   CN = Connecticut   CO = Colorado   DC =
Dist. of Col."
    print " DE = Delawai e   FL = Florida   GA = Georgia   HI = Hawaii
IA = Iowa"
    print " ID = Idaho   IL = Illinois   IN = Indiana   KY = Kentucky"
    print " KS = Kansas   LA = Louisiana   MA = Massachusetts   MD =
Maryland"
    print " ME = Maine   MI = Michigan   MN = Minnesota   MO = Missou-
ri"
    print " MS = Mississippi   MT = Montana   NE = Nebraska   NC = N.
Carolina"
    print " ND = N. Dakota   NH = New Hampshire   NJ = New Jersey   NM
= New Mexico"
    print " NV = Nevada   NY = New York   OH = Ohio   OK = Oklahoma"
    print " OR = Oregon   PA = Pennsylvania   RI = Rhode Island   SC =
S. Carolina"
    print " SD = S. Dakota   TN = Tennessee   TX = Texas   UT = Utah"
    print " VA = Virginia   VT = Vermont   WA = Washington   WI =
Wisconsin"
    print " WV = W. Virginia   WY = Wyoming"
    goto 801
    rem
    rem  -----Subroutine for OTHER Option-----
    rem  -----Asks for Information Normally Read from NAMES.I File----
-
    rem
800 delay 2
    print chr$(12): input " Enter name of location:",post$
    if ucase$(post$)="QUIT" goto 999
```

```
801 input " Enter two letter abreviation of state:",state$
    if ucase$(state$)="QUIT" goto 999
    if len(state$)> 2 or len(state$)<1 then print r3$: print: goto 801
    state$=ucase$(state$)
    if state$="MA" or state$="NH" or state$="VT" or state$="CN" or
state$="ME" or state$="RI" then region=1: goto 805
    if state$="NY" or state$="NJ" then region=2: goto 805
    if state$="PA" or state$="MD" or state$="WV" or state$="VA" or
state$="DC" or state$="DE" then region=3: goto 805
    if state$="KY" or state$="TN" or state$="NC" or state$="SC" or
state$="MS" or state$="AL" or state$="GA" or state$="FL" then re-
gion=4: goto 805
    if state$="MN" or state$="WI" or state$="MI" or state$="IL" or
state$="IN" or state$="OH" then region=5: goto 805
    if state$="TX" or state$="NM" or state$="OK" or state$="AR" or
state$="LA" then region=6: goto 805
    if state$="KS" or state$="MO" or state$="IA" or state$="NE" then
region=7: goto 805
    if state$="MT" or state$="ND" or state$="SD" or state$="WY" or
state$="UT" or state$="CO" then region=8: goto 805
    if state$="AZ" or state$="CA" or state$="NV" or state$="HI" then
region=9: goto 805
    if state$="WA" or state$="OR" or state$="ID" or state$="AK" then
region=10: goto 805
    print r3$
802 input " Would you like to see a list of State abreviations (Yes or
No)?:",yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="Y" goto 775
    if left$(ucase$(yn$),1)<>"N" then print r1$: goto 802
    goto 801
805 delay 2
    print chr$(12): print " Select what type of location this is:"
    print s$
    print " Troop Base                        1"
    print " Training Facility                 2"
    print " Industrial Facility               3"
    print " Medical Facility                  4"
    print " Office or Research Facility       5"
806 input " Type 1, 2, 3, 4, or 5:",in$
    if ucase$(in$)="QUIT" goto 999
    if in$="1" or in$="2" then macom$="T": goto 810
    if in$="3" then macom$="A": goto 810
    if in$="4" or in$="5" then macom$="M": goto 810
    print r3$: print " Expecting a value of 1 to 5": goto 805
810 delay 2
    print chr$(12): print " The effective population is the number of
people actually living in ";post$
    print " plus 2/3 of the people who only work in ";post$;"."
    input " Enter the effective population:",popu
    if ucase$(in$)="QUIT" goto 999
    delay 2
    print chr$(12): input " Enter the annual cost of landfill disposal
($/yr):",refcost
    if ucase$(in$)="QUIT" goto 999
    goto 50
    rem
    rem  -----Error Trap-----
    rem
989 close #2: resume 175
```

```
    rem
    rem  -----Subroutine to Read DOE Electrical Cost Info. from File--
---
    rem
990 open "I",#2,"fuel2.i"
    for n=1 to region
    input# 2,f(1),f(2),f(3),f(4),f(5)
    next n
    table=f(5)*100
    close #2
    return
    rem
    rem  -----Subroutine for Input of Information on Displaced and
Auxiliary Fuels-----
    rem
991 print: print " In which units do you wish to enter the cost of
";f$(i)
    print s$
    print " 1     $/MBtu"
    print " 2     $/";fcun$(i)                          ' cost in terms
of unit measure
    print " 3     don't know"
    input " Type 1, 2, or 3: ",in$
    if ucase$(in$)="QUIT" goto 999
    if val(in$)>0 and val(in$)<4 goto 992             ' check input
for validity
    print r3$
    print " Expecting a number between 1 and 3.": goto 991
992 m=val(in$)
    if m=2 then in$=fcun$(i) else in$="MBtu"
    rem  -----Ask for the Price of the Fuel-----
993 print: Print " Enter the cost of ";f$(i);" in terms of $/";in$
    input " else type ?: ",yn$
    if ucase$(yn$)="QUIT" goto 999
    if val(yn$)<0 then Print r3$: goto 993
    if yn$="?" then return
    j=val(yn$)
    rem  -----Give Them a Chance to Change Their Mind-----
994 print: print " You have specified a fuel cost of ";: print using
"$$#.##";j;: print "/";in$
    print r2$;: input ,yn$
    if ucase$(yn$)="QUIT" goto 999
    if left$(ucase$(yn$),1)="N" then print " Re-enter cost.": goto 993
    if left$(ucase$(yn$),1)<>"Y" then print r1$: goto 994
    rem  -----Open Appropriate File for Correct Units of Fuel Cost----
-
995 if m=2 then open "I",#2,"fuel2.i" else open "I",#2,"fuel1.i"
    for n=1 to region
    input# 2,f(4),f(5),f(2),f(3),f(1)
    next n
    table=f(i)
    close #2
    return
    rem
    rem  -----Set Label for Cost of Waste Disposal-----
    rem
996 if lfcu=1 then in$="/ton": return
    if lfcu=2 then in$="/cuy": return
    if lfcu=3 then in$="/ton"
    return
```

```
    rem
    rem  -----Set Label for Amount of Waste-----
    rem
997 if wqu=1 then in$="tpd (5day)": return
    if wqu=2 then in$="tpd (7 day)": return
    if wqu=3 then in$="tpy": return
    if wqu=4 then in$="cuy/d (5 day)": return
    if wqu=5 then in$="cuy/d (7 day)": return
    if wqu=6 then in$="cuy/yr": return
    if wqu=7 then in$="tpy": wqu=3: return
    if wqu=8 then in$="TPW": return
    print " Error in subroutine 997: return
    rem
    rem  -----Set Error Trap-----
    rem
998 close #1
    if s%=2 then s%=0: resume 200
    resume 10
    rem
    rem  -----CLOSE UP AND EXIT FROM THE PROGRAM-----
    rem
999 delay 2
    print s$
    print "     Goodbye from the Heat Recovery Incinerator Model"
    print s$
    end
```

HRIFEAS Batch Files

AUTOEXEC.BAT:

```
echo off
cls
echo If you desire to install HRIFEAS onto a hard disk,
echo press CTRL C and run HDINST; otherwise
pause
cls
echo Loading HRIFEAS program
SET COMSPEC = a:\command.com
a:
REM  This avoids accidental execution of previous LCCID file
if exist a:lcc_in  del a:lcc_in
hrifeas
b:
if exist a:lcc_in goto LCC
goto END
:LCC
   echo PLEASE WAIT...COMPUTING LIFE CYCLE COSTS...
   lccid < a:lcc_in > a:TEMP
   REM  This is to save space
   del a:TEMP
:END
   echo ANALYSIS COMPLETE...Reports can be printed from Drive A:
```

F$FND. :

```
 Volume in drive A has no label
 Directory of  A:\

EVAL90   DAT    22285   5-08-90  11:45a
        1 File(s)    250880 bytes free
```

LCCID.INI:

```
 Drive and Basic Path name for LCCID data files:
A:
 Drive and Basic Path name for User Generated Study and Report files:
A:
 Drive and path where LCCID program is stored:
B:
```

HDINST.BAT:

```
echo off
cls
echo This program is to install the HRI feasability software onto a
hard disk.
echo It will create a separate sub-directory on drive C
echo and install the necessary files onto it.
echo ------------------------------------------------------------
echo If this is not acceptable or correct, press CTRL and C at the
same time,
echo or press RETURN to continue.
pause
```

```
c:
md\hri
cd\hri
copy a:*.msg
copy a:hrifeas.exe
copy a:hd.01 F$FND.
copy a:hd.02 lccid.ini
copy a:hd.03 hri.bat
copy a:hd.bat
copy a:*.dat
copy a:*.I
copy a:more.com
hd.bat
```

HD.BAT:

```
echo off
cls
echo Please insert the disk labled "B" and
pause
copy a:lccid.exe
echo Installation is now complete!
echo Remove disks and type HRI to start program.
del hd.bat
```

HD.01 (F$FND.):

```
 Volume in drive C has no label
 Directory of  C:\HRI

EVAL90   DAT    22285   5-08-90  11:45a
        1 File(s)    250880 bytes free
```

HD.02 (LCCID.INI):

```
 Drive and Basic Path name for LCCID supplied data files:
 :
 Drive and Basic Path name for User Generated Study and Report files:
 :
 Drive and path where LCCID program is stored:
C:\HRI\
```

HD.03 (HRI.BAT):

```
echo off
cls
echo Loading HRIFEAS program
SET COMSPEC = c:\command.com
c:
cd\hri
REM  This avoids accidental execution of previous LCCID file
if exist lcc_in  del lcc_in
hrifeas
if exist lcc_in goto LCC
goto END
:LCC
```

```
   echo PLEASE WAIT...COMPUTING LIFE CYCLE COSTS...
   lccid < lcc_in > TEMP
   REM  This is to save space
   del TEMP
:END
   echo ANALYSIS COMPLETE...Reports can now be printed.
```

APPENDIX B: Air Pollution Control Equipment Cost Estimates

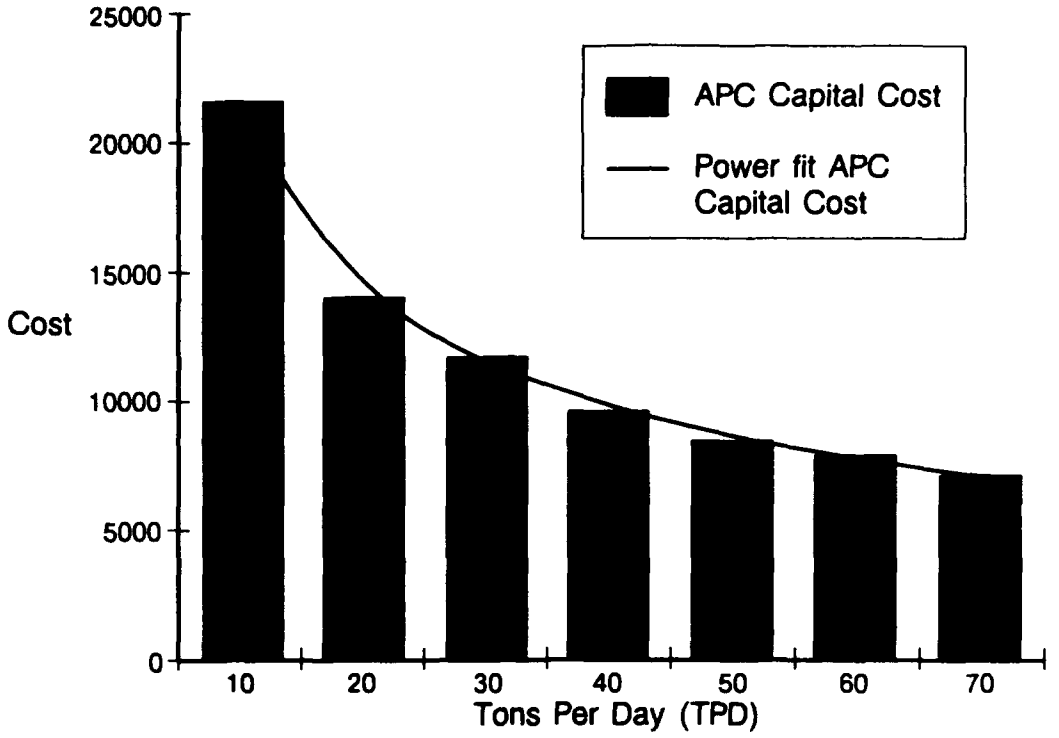

Figure B1. Air pollution control (APC) capital cost.

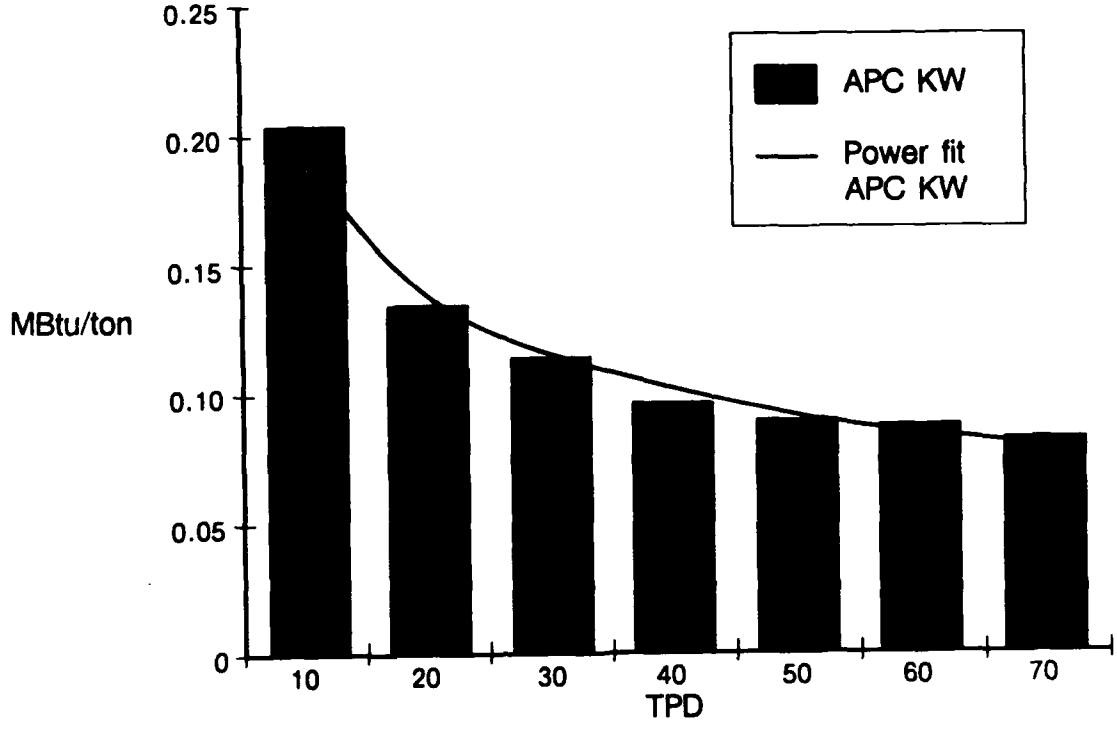

Figure B2. APC electrical demand.

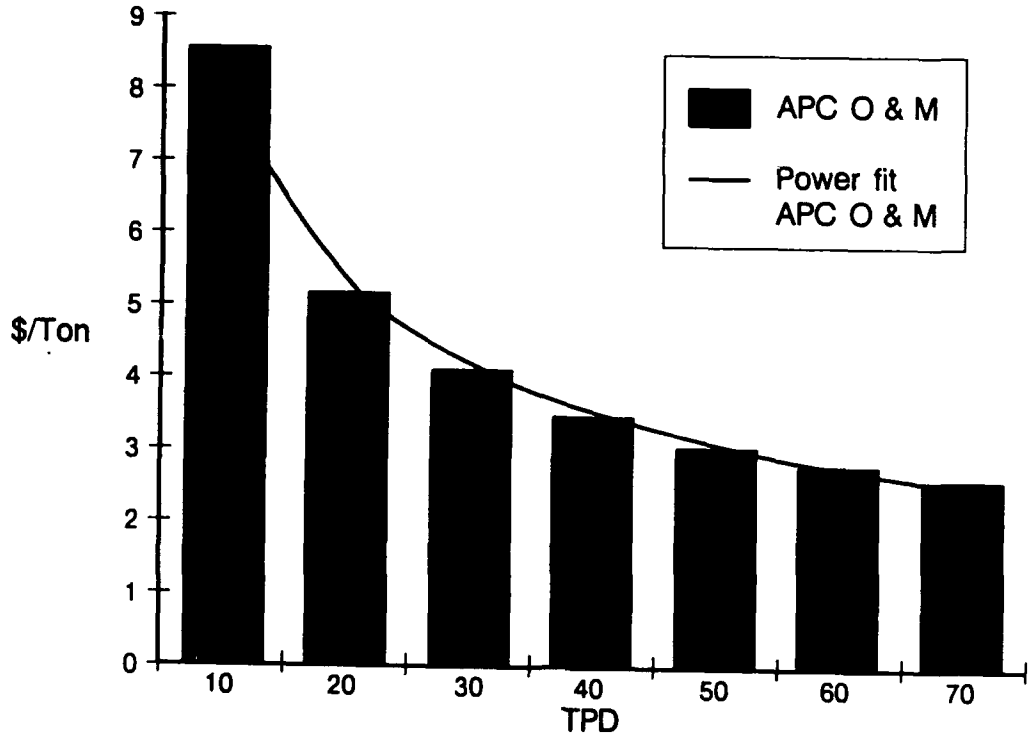

Figure B3. APC operation and maintenance cost.

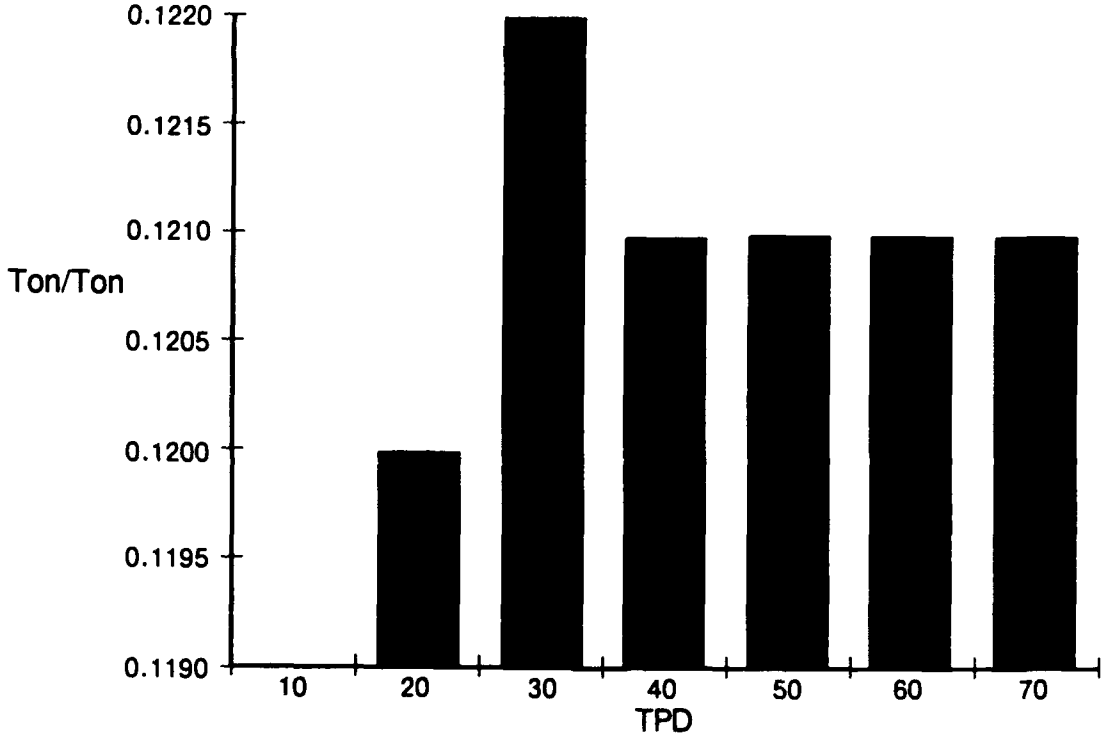

Figure B4. APC residue accumulation.

USACERL DISTRIBUTION

Chief of Engineers
ATTN: CEHEC-IM-LH (2)
ATTN: CEHEC-IM-LP (2)
ATTN: CECG
ATTN: CERD-M
ATTN: CECC-P
ATTN: CERD-L
ATTN: CECW-P
ATTN: CECW-PR
ATTN: CEMP-E
ATTN: CEMP-C
ATTN: CECW-O
ATTN: CECW
ATTN: CERM
ATTN: CEMP
ATTN: CERD-C
ATTN: CEMP-M
ATTN: CEMP-R
ATTN: CERD-ZA
ATTN: DAEN-ZCM
ATTN: DAEN-ZCE
ATTN: DAEN-ZCI

CEHSC
ATTN: CEHSC-F 22060
ATTN: CEHSC-TT 22060
ATTN: CEHSC-ZC 22060
ATTN: DET III 79906

US Army Engr District
ATTN: Library (40)

US Army Engr Division
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US Army Europe
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